JULY
1953

MECHANICAL ENGINEERING

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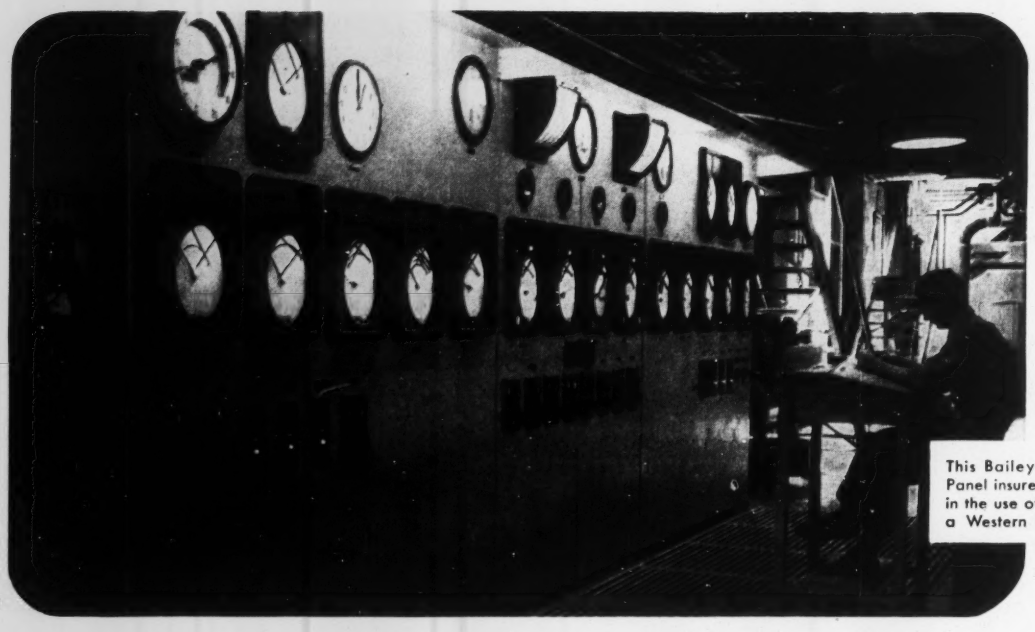

This Bailey Boiler Control Panel insures high efficiency in the use of Fuel-Dollars at a Western Chemical Plant.

What's Your Fuel-dollar Efficiency?

A dollar's worth of fuel has the *same potential* energy, no matter who's boiler it fires. But how much of the energy actually gets converted to a usable form depends on how you operate your boiler.

That's where Bailey Controls can help. And, here's why, we believe, you'll get better fuel-dollar efficiency with Bailey:

1. **Complete Range of Equipment—fully co-ordinated.** You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control systems.

2. **Engineering Service—backed by experience.** No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement and automatic control.

3. **Direct Sales-Service—conveniently located near you.** Bailey Meter Company's Sales-Service Engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum of travel time and expense.

For better fuel-dollar efficiency—for more power per fuel-dollar, less outage and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More power to you!"

A-109-1

BAILEY METERS

BAILEY METER COMPANY

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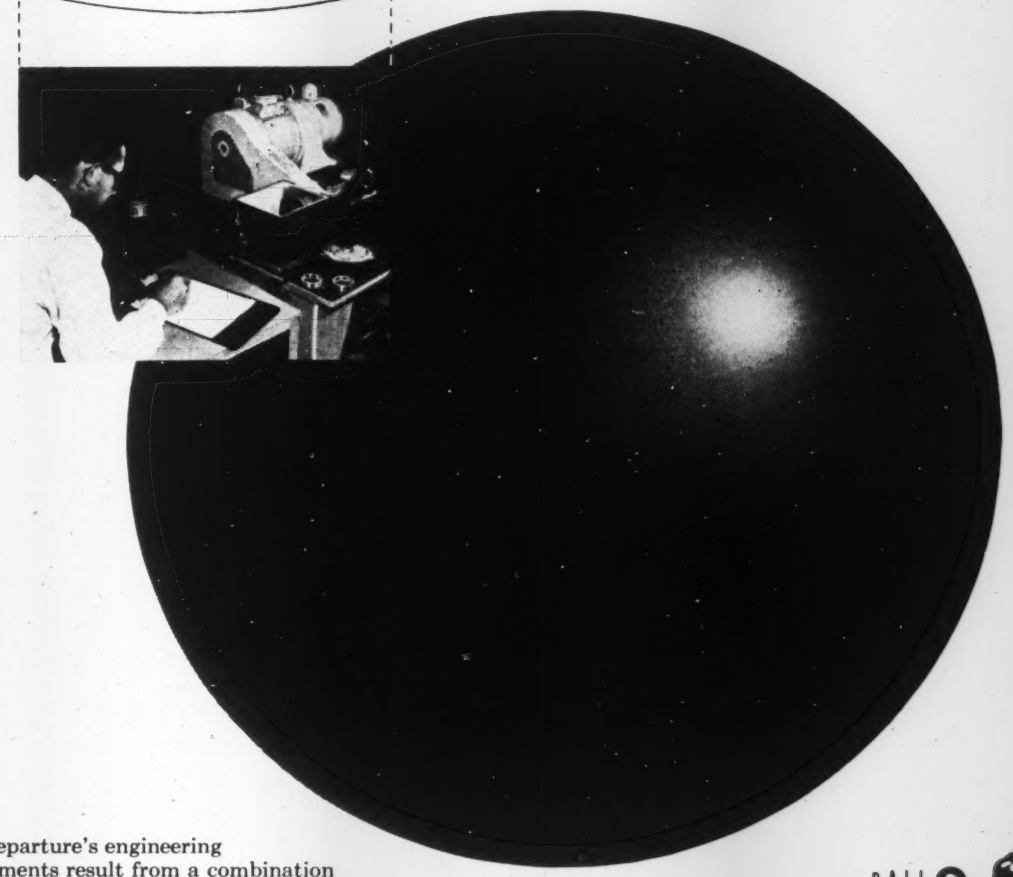
Controls for Steam Plants

Engineering Excellence



New Departure's engineering achievements result from a combination of many talents and techniques. From never-ending research to application advice with 60 years of experience behind it, every resource of New Departure is aimed directly at engineering excellence.

High manufacturing standards hold tolerances, in many instances, to limits measured in millionths of an inch. Scientific inspections make certain that component parts, as well as completed bearings, will perform as prescribed.

New Departure products are found wherever the forces of friction must be defeated. Miniature bearings for delicate instruments or large units for industrial installations, and anything in between, can be supplied by New Departure. Keep your eye on the BALL to be sure of your BEARINGS!

NOTHING ROLLS LIKE A BALL

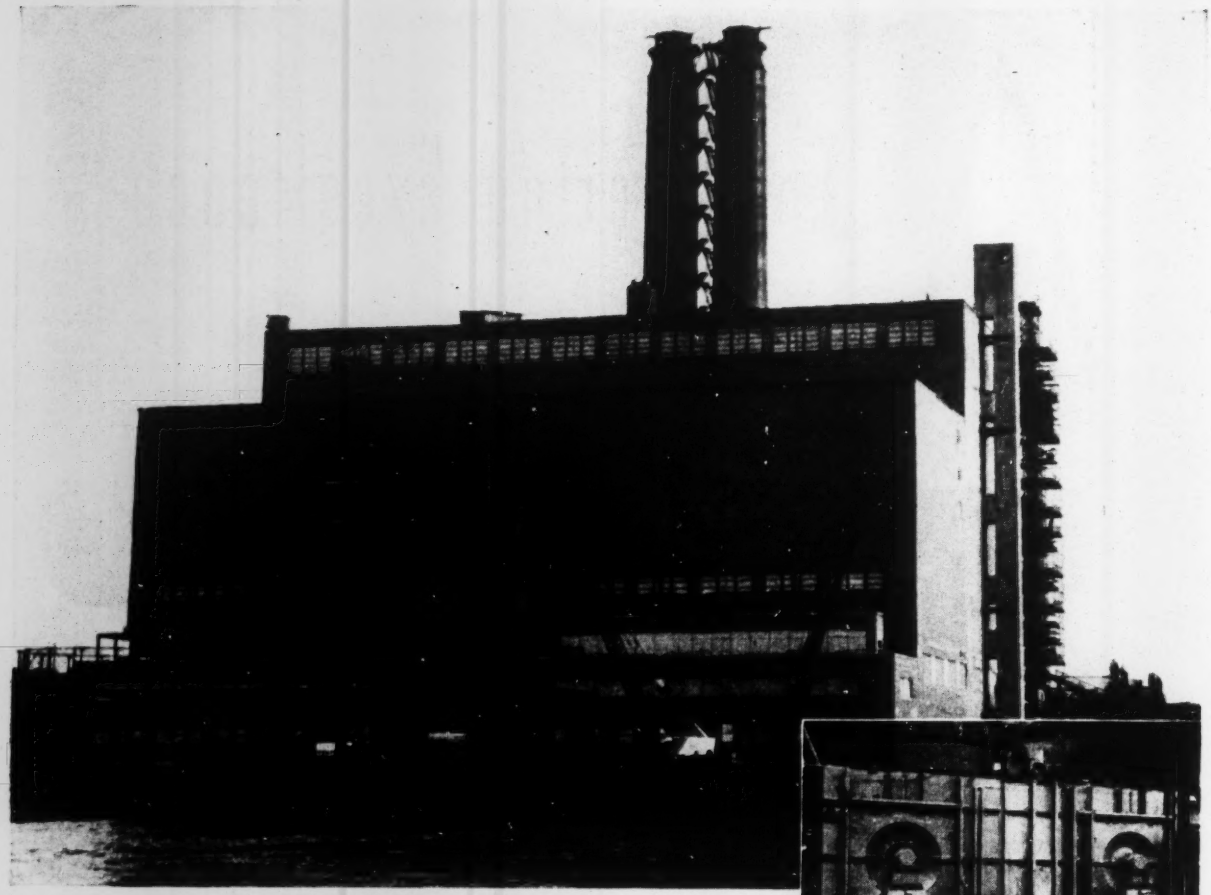
NEW DEPARTURE

BALL BEARINGS

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT

Also Makers of the Famous New Departure Coaster Brake

MECHANICAL ENGINEERING, July, 1953, Vol. 75, No. 7. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members and affiliates one year $3.50, single copy 50¢; to nonmembers one year $7.00, single copy 75¢. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations



Astoria's 1,200,000 lb. boilers are among the world's largest. Sturtevant fans furnish 600,000 CFM forced draft on each.

NEW AIRFOIL FANS

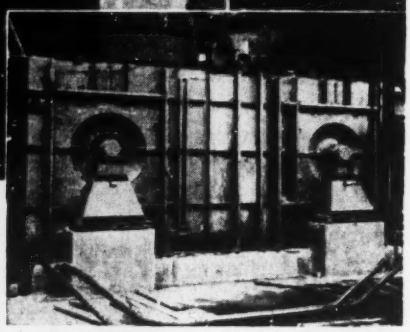
GIVE GREATEST ECONOMY AT ASTORIA

Pressurized boilers at Consolidated Edison's Astoria Station are designed to operate without induced draft. In a fan arrangement never before used by a public utility, eight new Sturtevant Airfoil-Bladed Fans are connected in series of two for forced draft.

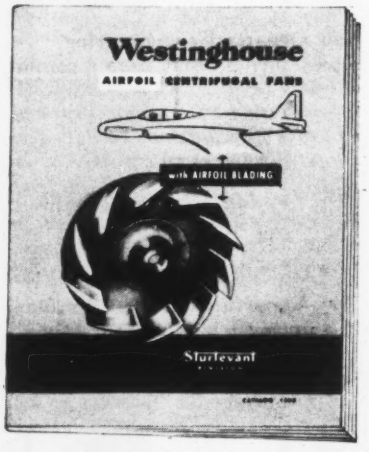
Each tandem is rated for 300,000 CFM at 38" pressure. At part loads, only one fan of each pair is used. Thus the fans operate at or near peak efficiency at all times.

Airfoil-Bladed Fans retain the self-limiting horsepower characteristics and reach peak efficiencies of *over 90%*. They are designed primarily for application where low operating cost and quiet operation mean more than first cost.

For full information on the Airfoil-Bladed Centrifugal Fan, ask for new Catalog 1320. Call your Westinghouse-Sturtevant office. Westinghouse Electric Corp., Sturtevant Division, Hyde Park 36, Mass.



The "boxcar" being installed above houses two Airfoil Fans in tandem. Two units totaling four fans serve each boiler. A unique by-pass system permits operation of any two fans in each four-fan unit. All fans are equipped with power-saving Vane Control * to permit instantaneous control of output.

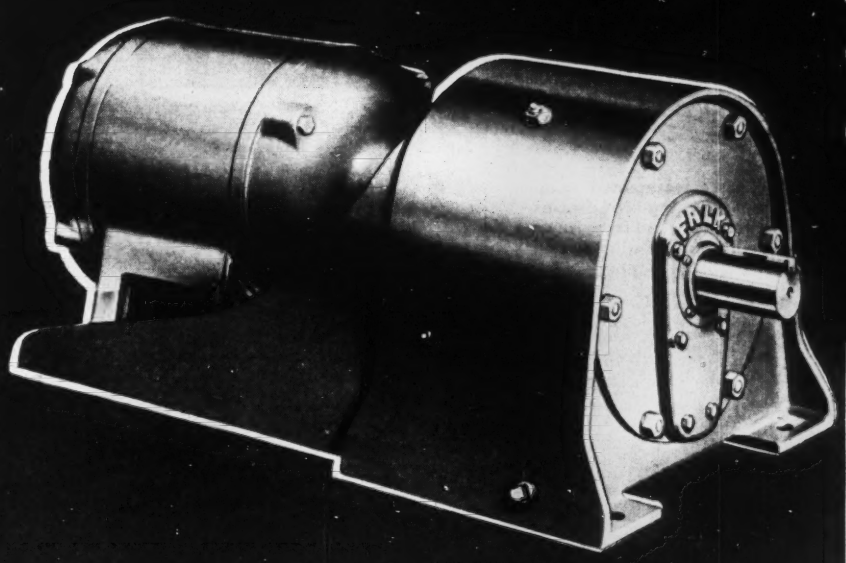


WESTINGHOUSE AIR HANDLING

YOU CAN BE SURE... IF IT'S **Westinghouse**

J-80314

Choose the All-Motor type,



...with complete foot-mounted motor of ANY make ANY type ANY speed

Its exclusive, superior features mean LONG-RANGE ECONOMY!

The FALK all-steel, All-Motor type Motoreducer provides superior features and advantages found in no other reduction unit. Here is the only compact motorized reducer with a separate foot-mounted, resilient Steelflex coupling-connected, standard motor *without modifications!* It accommodates *any* make, type, or speed of motor within the AGMA rating of the unit.

The simplified construction of the FALK All-Motor type Motoreducer means real long-range economy. The assembly is highly versatile; it permits the use of special purpose couplings, brakes, fluid drives or other adaptations without modification of reducer or motor other than the addition of the special features. Standard motors from manufacturers' field stocks are always available without costly delivery delays or special motor or shaft modification.

When you choose a FALK All-Motor type Motoreducer, you get the utmost in design and dependability of performance—plus the greatest possible dollar-for-dollar value throughout its traditionally long life . . . Available in standard ratios for stock shipment. Write for Bulletin 3104.

FALK ...a good name in industry

THE FALK CORPORATION 3001 W. Canal St. Milwaukee 8, Wis.

Every FALK motoreducer has these "IN-BUILT" FACTORS

1 **All-steel Housings.** Unbreakable, strong, rigid. Generous overhung load capacities provided by wide bearing spans, large shafts and bearings.

2 **Streamlined inside and outside.** Smooth, clean surfaces; machine welded construction conforms to NEMA motor frames.

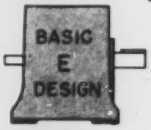
3 **Sealed Housings.** Dual closures and one-way vents keep oil *in*, dust and moisture *out*. Units are splashproof, leakproof, dustproof.

4 **Positive Lubrication.** Large sump capacity ...oil-tight construction assures clean lubricant...direct dip of revolving elements provides positive lubrication at all speeds.

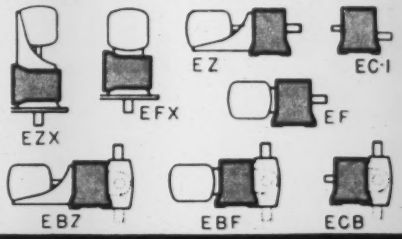
5 **Wide Speed Range.** Selective ratio combinations provide output speeds from 1.5 rpm to 1430 rpm with stock gears.

6 **Precision Gearing.** Heat-treated alloy steel, precision cut and shaved helical gearing throughout...quiet-operating crown shaved pinions...taper bored gears for easy ratio changes.

• • •



The basic E design permits maximum use of standardized parts . . . closer control over materials, processing, inspection and assembly . . . resulting in faster delivery from interchangeable stocked assemblies.

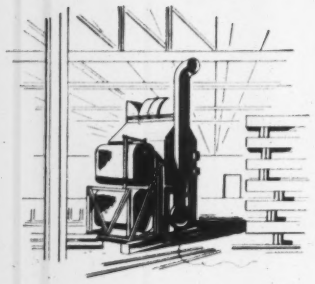


WRITE FOR BULLETIN 3104

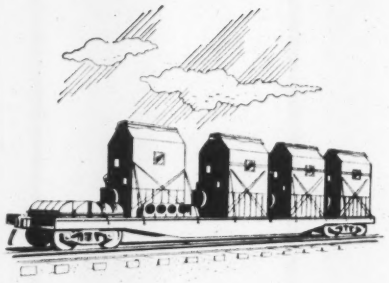
These 12 DRAVO *Counterflo* SPACE HEATERS really got around!

Here's where the Dravo Heater's rugged construction and durability paid off for Ford Motor Company.

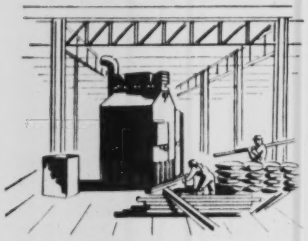
Back in the fall of 1950, Ford purchased 12 Dravo Heaters for temporary heating at Cleveland, Ohio, while Ford's new engine plant was under construction during the winter of 1950-1951.



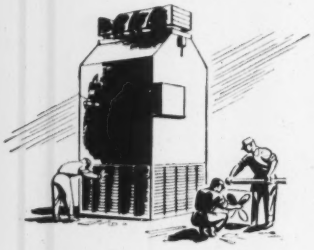
1 The heaters maintained comfortable working conditions and kept the ground from freezing during zero weather so that concrete could be poured.



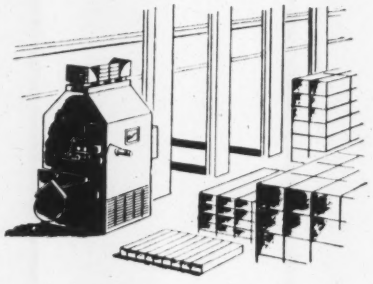
2 After this new plant was completed, four heaters were shipped to Canada and were permanently installed in Ford's warehouse at Winnipeg.



3 The other eight heaters were shipped to Kansas City, Mo., for use as temporary heaters during the construction of facilities similar to those in Cleveland.



4 When that job was finished, the eight heaters were returned to Dravo at Neville Island, Pittsburgh, for overhauling and reconditioning by highly-skilled Dravo personnel.



5 Now these eight Dravo *Counterflo* Heaters have been permanently installed for comfort heating at Ford's assembly plant at Buffalo, New York.

Only Dravo *Counterflo* Space Heaters could stand up under such extraordinary treatment and frequent moving. Dravo Heaters are a product of top-flight engineering and planning; their mill-type, heavy construction means long life, low maintenance and years of satisfactory service.

Dravo Heaters, backed by over 60 years of engineering experience, are available now in a range of sizes from 400,000 to 2,000,000 Btu. Find out how these superior Dravo Heaters can benefit you. Write for more information. Use the coupon.

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- ☐ Space heating industrial buildings, warehouses, garages, hangars.
- ☐ Stores, schools and auditoriums.
- ☐ Process drying and heat curing.
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- ☐ For use in conjunction with air conditioning.
- ☐ Please have a representative call at no obligation to me.

Name _____ Title _____

Company _____ Address _____

City _____ Zone _____ State _____

Fully Crowned Tooth Design Can Be Used To Solve Your Long-Standing Coupling Problem

A major improvement in gearing for power transmission—a fundamental improvement in gear tooth design that practically eliminates all "end tooth and tip" contact and provides greater freedom of axial movement distinguishes Amerigear Couplings from common gear-type couplings. Amerigear Couplings offer many more advantages than are obtainable with the common basic designs. The Amerigear Crowned Tooth Design can be applied wherever couplings are required. There are many instances where this design has been utilized to simplify power transmission mechanisms and add reliability to their performance in a measure heretofore found impossible.

If your problem arises from excessive offset or angular misalignment, tight back lash requirement, space limitations, high speeds and loads, or any combination of these, the solution is best made by the utilization of the Amerigear Fully Crowned Tooth. Amerigear engineers are available for consultation.

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Oil Seals of Amerigear Couplings Are As Advanced In Design, Performance, And Effectiveness As Is The Amerigear Fully Crowned Tooth.
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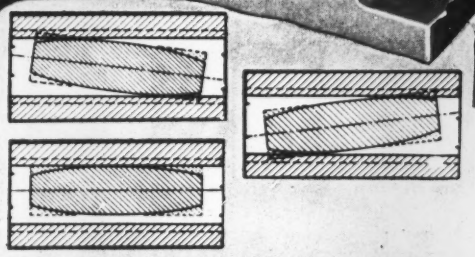

Comparison Of Amerigear Fully Crowned Tooth Design With Gearing Of Conventional Gear-Type Couplings Shows How "End Tooth And Tip" Contact Is Practically Eliminated And Why Greater Freedom Of Axial Movement Is Provided By Amerigear Fully Crowned Tooth Design (dotted lines indicate gear teeth of conventional gear-type coupling).

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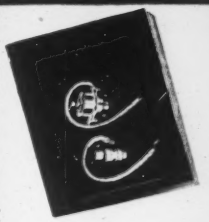

AMERICAN FLEXIBLE COUPLING COMPANY
ERIE, PA., U. S. A.

Please send me further information regarding AMERIGEAR COUPLINGS with the fully Crowned Teeth and Catalog No. 501.

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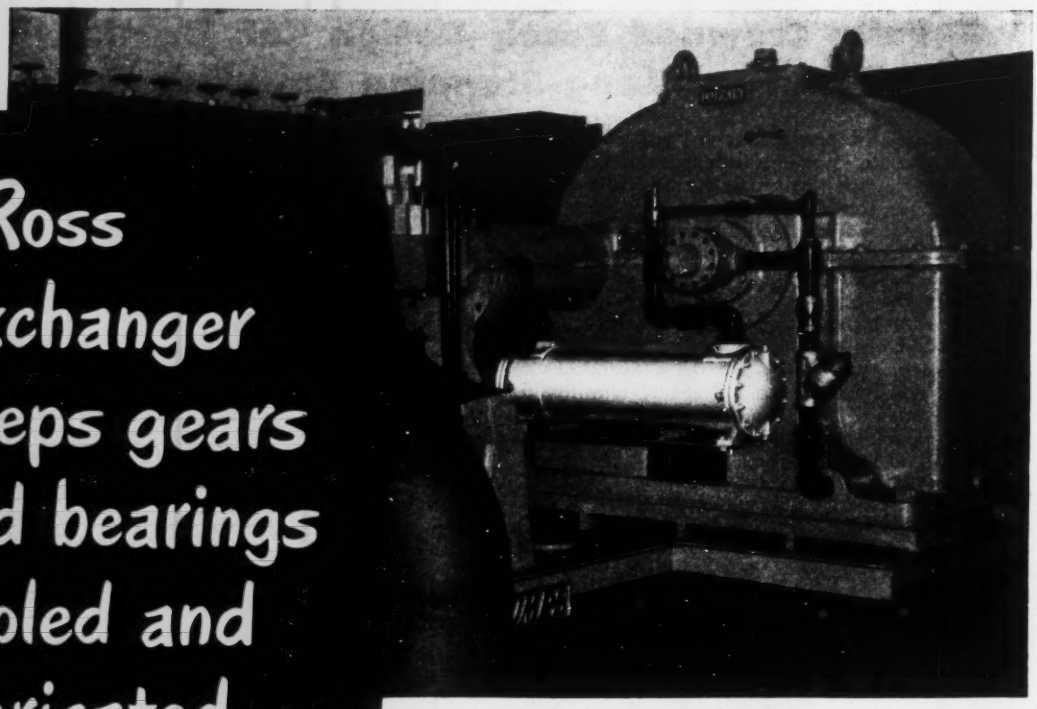
Please attach to your business letterhead



a Ross Exchanger keeps gears and bearings cooled and lubricated

in this Lufkin high speed increaser

Under the high speeds and peak loads of pipe line pump station service . . . precision gears and bearings in this Lufkin Type N High Speed Increaser not only *need* adequate lubrication and cooling . . . *they depend on both!*

. . . *and they get both!* Lufkin Foundry and Machine Company furnishes a Ross Type BCF Exchanger. "A most vital part of the cooling system," says Lufkin. By controlling the oil temperature in this way, not only is viscosity maintained for adequate lubrication of gears and bearings, but they are properly cooled as well.

Why Ross Exchangers?

Here's what Lufkin's Engineering Department has to say:

"We wanted a quality exchanger that we could install and forget."

"Our unit required a large capacity exchanger for a small, compact space . . . without altering the design of the unit."

"Since we have 33 sizes of Type N units, we needed to have many different sizes of exchangers."

"Very often the customer has to use salt water or sour crude as a cooling liquid."

"The pressure of the cooling liquid sometimes becomes excessive for most exchangers."

Throughout industry, other top-name machinery manufacturers, like Lufkin, list equally specific reasons for standardizing on Ross Type BCF Exchangers. They prefer the pre-engineered, completely standardized designs; the all-copper and copper alloy construction and the wide range of sizes to meet all conditions.

More details on the rugged dependable Ross Type BCF Exchanger are in Bulletin 1.1K5. Write for your copy.

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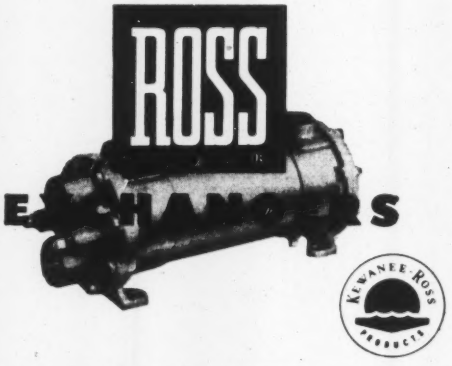
In Canada: Kewanee-Ross of Canada Limited, Toronto 5, Ont.



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Link-Belt Research and Engineering . . . Working for Industry

How precision Link-Belt bearings help speed America's production lines

Continuous steel strip is electrolytically tinplated at 1500 feet per minute —almost twice the speed of previous comparable lines. Link-Belt roller bearing pillow blocks support the shafts on each end of the 26 contact rolls.

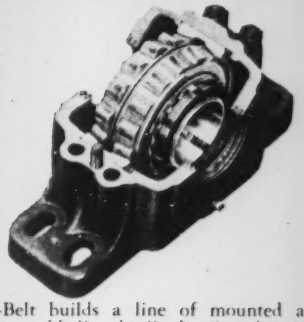
Full load ratings are maintained under the toughest operating conditions

CLOSE "in action" inspection demonstrates the dependability and quality of Link-Belt bearings in severe production line operations. Even with high speeds, grit, excessive temperatures and heavy loads, these integrally self-aligning bearings provide full radial and thrust load capacities.

That's why designers of so many hard-working machines specify Link-Belt ball and roller bearings. And when you use Link-Belt bearings, you can be sure they will provide long-life, free-rolling shaft support.

Next time you're in a mill or factory . . . on a farm or in the oil fields—take a look around you. Chances are good that the vital rotating parts of the equipment you see are mounted on Link-Belt bearings.

Throughout industry, you'll find Link-Belt power transmission, conveying and processing equipment at work. And in every instance, you'll discover these quality products pay dividends in cutting costs . . . increasing output . . . making America more productive.



Link-Belt builds a line of mounted and unmounted ball and roller bearings for every industrial need. More, Link-Belt bearings are used as original components for many of America's hardest-working machines.

LINK-BELT

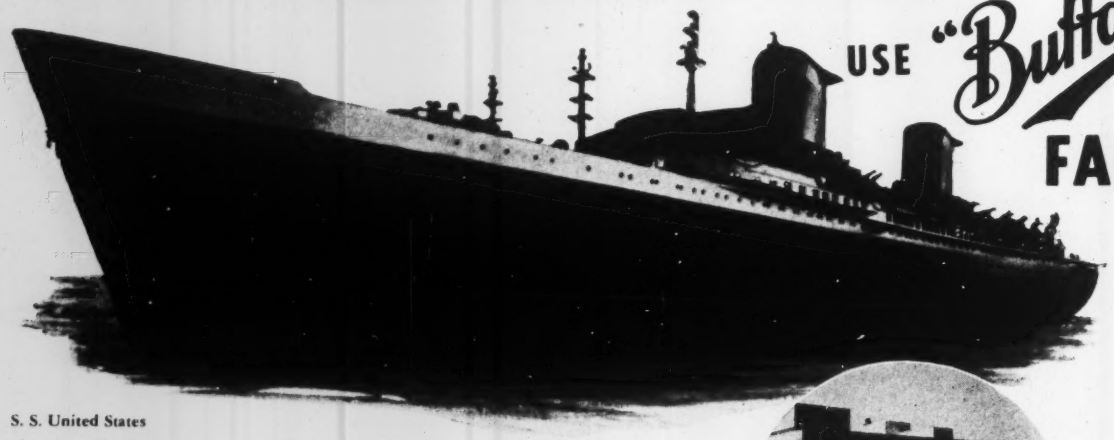
LINK-BELT COMPANY

Executive Offices:
307 N. Michigan Ave., Chicago 1, Ill.
Plants: Chicago, Indianapolis, Philadelphia, Colmar Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle; Scarboro, Toronto and Elmira, Ont. (Canada); Springs (South Africa); Sydney (Australia).
Sales Offices in Principal Cities. 13,285

ONE SOURCE . . . ONE RESPONSIBILITY FOR MATERIALS HANDLING AND POWER TRANSMISSION MACHINERY

THE WORLD'S FINEST LINER
THE WORLD'S FINEST HOTELS

USE "Buffalo" FANS



S. S. United States

It's nice to know that when really fine ventilating and air conditioning performance is required, "Buffalo" Fans are selected for the job.

The three new post-war hotels, which have made front page news, and the world's finest and fastest ocean liner, all depend on "Buffalo" Fans to maintain their "air of distinction."

WHY?

The "Q" Factor — The built-in Quality which provides trouble-free satisfaction and long life.

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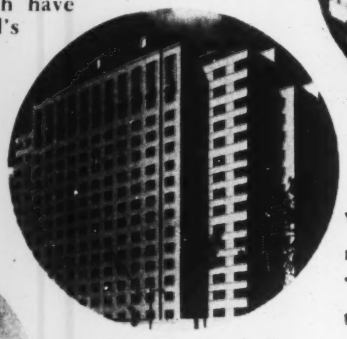
Los Angeles



The Shamrock, Houston

We believe you'll agree that its more than coincidence that "Buffalo" Fans were chosen for these outstanding jobs.

Terrace Plaza
Cincinnati

We will continue to build the "Q" Factor into "Buffalo" Fans, Air Cleaning and Conditioning Equipment, so that you may continue to specify it, with the assurance that you'll get your money's worth.

Engineering Sales Representatives in all principal cities are anxious to work with you.

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FOR FANS

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PUBLISHERS OF "FAN ENGINEERING" HANDBOOK

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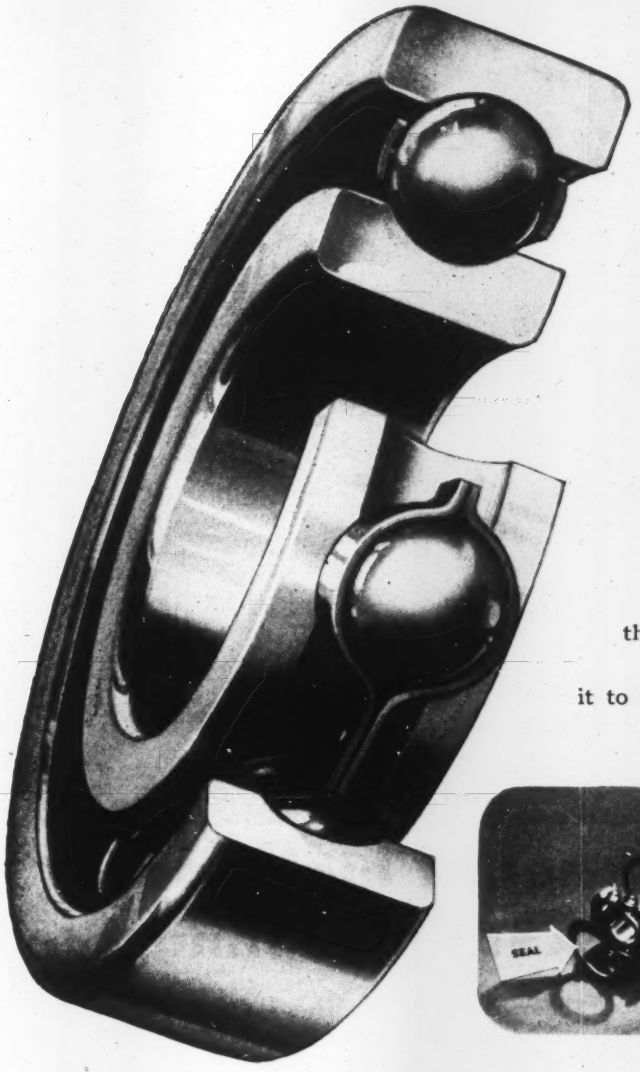
FORCED DRAFT COOLING HEATING PRESSURE BLOWING



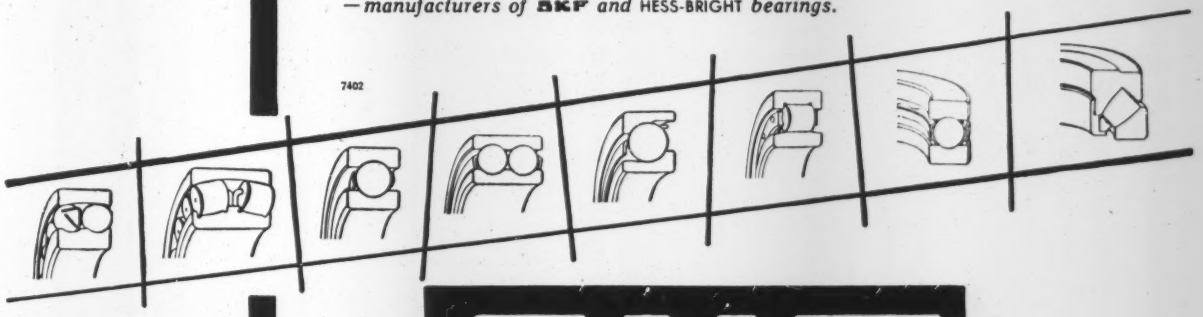
where shafts must turn fast you'll find SKF SINGLE ROW DEEP GROOVE BALL BEARINGS

Look at the *contact* between the balls and the deep, continuous groove in each ring of this SKF bearing—contact that enables it to sustain not only radial load, but substantial thrust load, even at very high speeds.

Look further—SKF Single Row Deep Groove Ball Bearings are available with *any combination* of DuPont Fairprene seals, shields and snap rings: shields for excluding dirt; seals for retaining lubricant; snap rings for holding the bearing in lateral position in its housing.

Like all SKF Bearings, they're held well within established tolerance limits, tested for radial runout, carefully cleaned, protected from rust, strongly packaged.

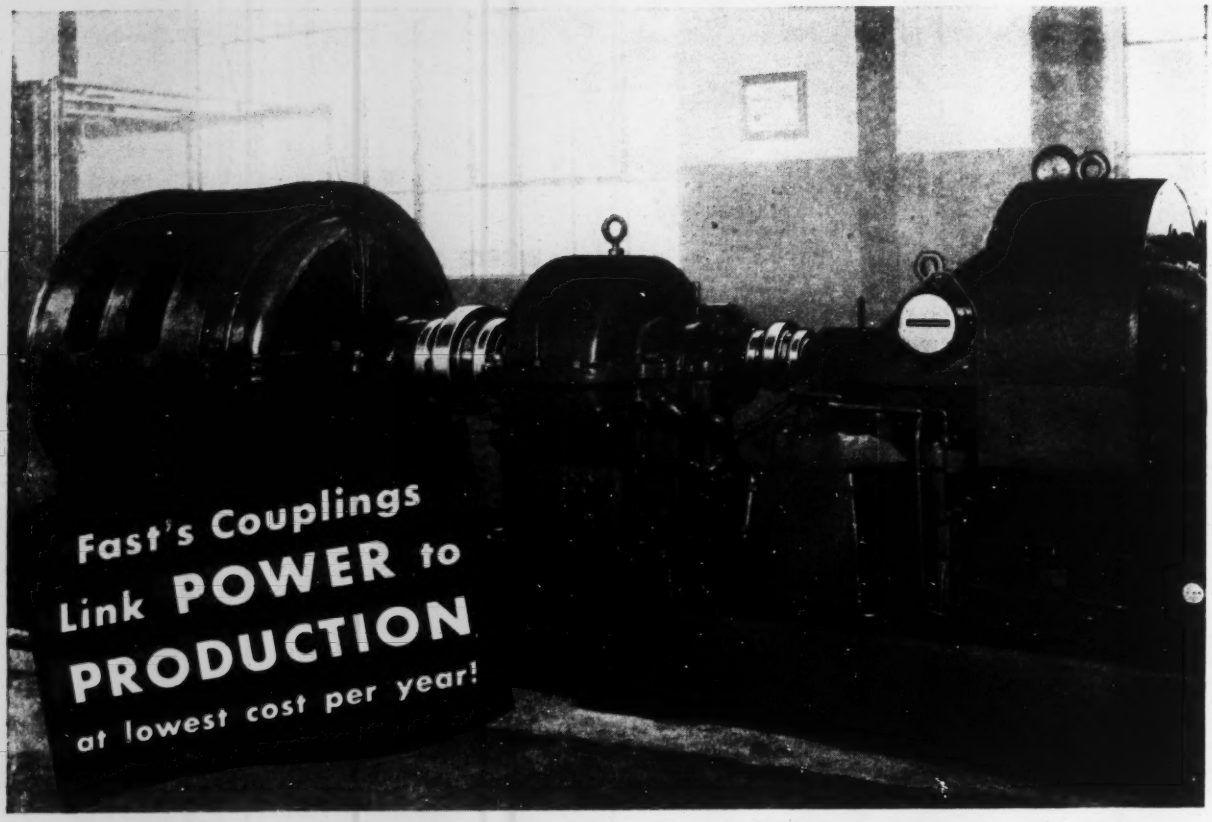
Many SKF bearings are serving industry everywhere because SKF's unmatched Field and Home Office engineering service helped product designers *put the right bearing in the right place.* **SKF INDUSTRIES, INC.,** PHILADELPHIA 32, PA. *—manufacturers of* **SKF** *and* HESS-BRIGHT *bearings.*



SKF'S COMPLETE LINE OF ANTI-FRICTION BEARINGS, PLUS **SKF** ENGINEERING CO-OPERATION, HELPS YOU PUT *THE RIGHT BEARING IN THE RIGHT PLACE.*

SKF®

BALL AND ROLLER BEARINGS



Every major producer of high-speed equipment uses FAST'S Couplings!

HIGH-SPEED equipment demands components with superior strength, accurate manufacture, long-lasting dependability. That's why it's important to *you* that Fast's Couplings are selected by every major high-speed equipment producer!

Fast's usually outlast the equipment they connect. Many have been in continuous operation for over 30 years, without trouble of any kind. And Fast's longer life saves you coupling dollars, too, because you amortize their cost over many years of trouble-free operation.

For full details on Fast's Couplings and Koppers Engineering Service, write today for your free copy of our catalog. Send to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 257 Scott St., Baltimore 3, Maryland.

KOPPERS

FAST'S
THE ORIGINAL
GEAR-TYPE
Couplings

INDUSTRY'S STANDARD FOR 32 YEARS

Here's How FAST'S Save You Money

Free Service—Koppers free engineering service assures you the right coupling for the job.

Rugged Construction—Fast's still maintains its original design, without basic change or sacrifice in size or materials. Result: freedom from expensive coupling failures.

Lowest Cost per Year—Fast's Couplings usually outlast equipment they connect. Their cost may be spread over many years!

KOPPERS COMPANY, INC., ***Fast's Coupling Dept.***
257 Scott St., Baltimore 3, Md.

Gentlemen: Send me Fast's Catalog which gives detailed descriptions, engineering drawings, capacity tables and photographs.

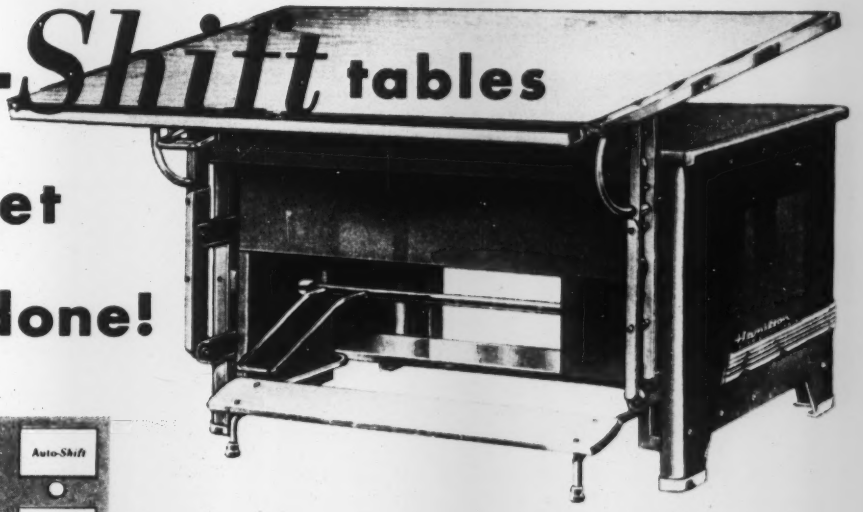
Name .....

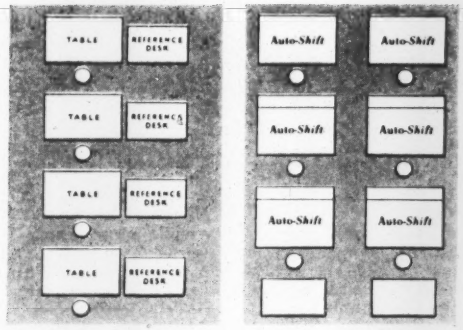
Company .....

Address .....

City ..... *Zone* ..... *State* .....

Auto-*Shift* tables help get the work done!



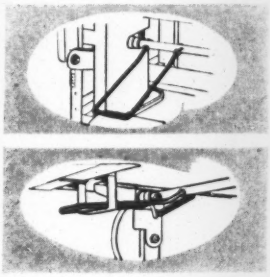


30-50% greater floor space efficiency

Approximately 250 sq. ft. of floor space accommodates *two more* Auto-*Shifts* than board-next-to-desk tables. Space efficiency *and* operating efficiency are greater, since Auto-*Shift* puts large reference surface directly behind each draftsman—instantly, effortlessly accessible.

HEIGHT ADJUSTMENT

SLOPE ADJUSTMENT



Greatly reduced draftsman fatigue

Auto-*Shift* provides rapid, simple adjustment of both board height and slope—permits draftsmen to change working position frequently. Convenient foot release frees top for height adjustment—hand release permits rapid slope adjustment. Fully counterbalanced top moves effortlessly.

Excels in row installations

Auto-*Shift* efficiency reaches a peak in row installations. Each draftsman has a full-size extension reference surface directly behind him, generous drawer space immediately at hand. Everything is where he needs it to work quickly and accurately. Auto-*Shift* helps get the work done!

Here is the complete Auto-*Shift* story

Get all the Auto-Shift facts, including new range of sizes, data on new models for use at front and rear of row installations. Write for your copy today.

Drafting Equipment Division

Hamilton Manufacturing Company

Two Rivers, Wisconsin

How would YOU solve these two problems?

1. HE LIKES LIFE SAVERS because they're good. Life Savers Corporation had the problem of *exactly* determining candy moisture content — required 1°F temperature control — found this *accuracy* in Fenwal All-Purpose THERMOSWITCH® unit. Cost of control was low — results excellent.

2. PARAFFIN BATHS are important physical therapy equipment. For safety, temperature must be held within close limits. Makers of Dickson Paraffin Baths selected Fenwal THERMOSWITCH devices as entirely dependable and accurate in controlling heating unit.

3. A FENWAL THERMOSWITCH CONTROL may solve your problems, too. Its external, single-metal shell expands or contracts *instantly* with temperature changes, making or breaking enclosed electrical contacts. Compact, highly resistant to shock and vibration, Fenwal THERMOSWITCH units have solved hundreds of otherwise costly problems.

4. SEND FOR THIS NEW CATALOG for complete explanation of the unique THERMOSWITCH unit. Also ask for more detailed, illustrated discussions of the problems above. Fenwal engineers will be glad to help you solve your temperature control problems involving heat, humidity, radiant heat, pressure and other variables. **Write Fenwal Incorporated, 57 Pleasant Street, Ashland, Massachusetts.**

Fenwal

THERMOSWITCH®

Electric Temperature Control and Detection Devices

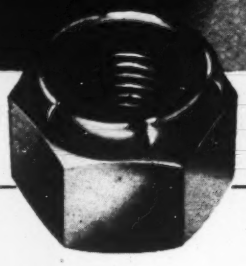
SENSITIVE... *but only to heat*

Wobble means wear

Formula for Failure

$$\frac{w + e + s + \alpha}{\times\ v} =$$

a loose connnection



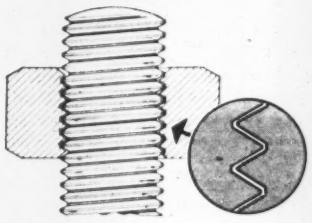
Elastic Stop nuts can't wobble

Formula for Failure—[(w) Initial thread wear + (e) bolt stretch + (s) thermal expansion or contraction + (α) wobble] × (v) vibration = a loose connection.

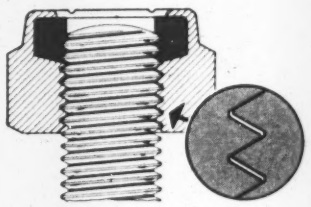
WOBBLE, permitted by normal axial thread play, and vibration are two of the major elements contributing to thread wear, loose connections and ultimate failure of a threaded fastener.

One device — the elastic locking insert — eliminates axial play and dampens destructive, wear-producing vibration. Because of the locking action of ESNA's famous red elastic collar, ELASTIC STOP nuts *do not loosen under vibration.*

Other important ESNA advantages include quick application and precise adjustment, reuseability, protection against liquid seepage, and uniform bolt loading. Mail our coupon for design information.



YOU CAN WOBBLE AN ORDINARY NUT AND BOLT with your fingers. This is the result of the tolerance spread permitted by the several classes of thread fit.



GRIPPING THE BOLT WITH A PERFECT FIT, ESNA's red elastic collar enforces a constant downward pressure that eliminates axial play, enforcing a positive contact between load-carrying sides of bolt and nut threads.

ELASTIC STOP NUT CORPORATION OF AMERICA

also maker of the ROLLPIN

Elastic Stop Nut Corporation of America
Dept. N36-711, 2330 Vauxhall Road, Union, N. J.
Please send the following free fastening information:

☐ ELASTIC STOP nut bulletin

☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name _____ Title _____

Street _____

City _____ Zone _____ State _____

HIGH TENSILE

ANCHOR

HIGH TEMPERATURE

SPLINE

CLINCH

GANG CHANNEL

NYLON CAP

Only ESNA manufactures a complete line of all types and sizes of self-locking nuts

valve values
PHOTO NEWS

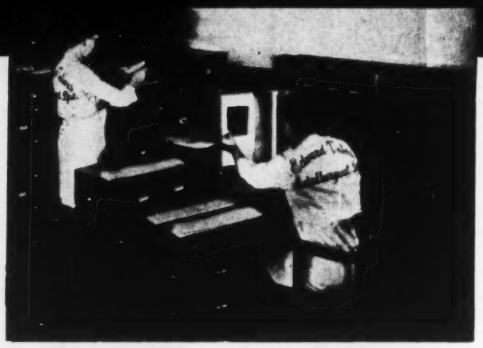
Radioactivity, Magnetism Assure Edward Valve Soundness

The technician above is using Cobalt-60, a radioactive isotope obtained from U. S. and Canadian Atomic Energy Commissions in the radiographic examination of an Edward Fig. 4006Y cast steel valve. Using gamma-rays, the radiographic technique gives photographic evidence of the internal structure of metals, instantly reveals internal voids or weaknesses not capable of detection by any other method.

Radiographic inspection is an old story at Edward. In use since 1928, Edward has built up a file of over 203,000 radiographic negatives attesting to the soundness of valves already in service. And the backlog of experience gained in applying and interpreting radiographic methods over the years assures Edward customers of the greatest possible measure of protection from this technique.

Radiography is only one of many methods, some old, some new, used in thoroughly inspecting all materials that make up Edward Valves. A new testing procedure is illustrated at right—a magnetic-electronic device which tests bar stock entering the Edward plant, assuring 100% soundness and uniformity in the materials used for stems, studs, and other vital valve components. By measuring variations in electrical and magnetic characteristics, this unit reveals any deviations in hardness, chemical analysis, or grade, and any internal cracks or structural differences. It can even tell whether two bars came from the same or different "heats."

Inspection procedures like these illustrate the determination at Edward to quickly adopt every modern technological development which permits further verification of the superiority of our materials, manufacturing methods or designs. These continual checks have helped to build the reputation for dependability in service which is our most valuable asset—and one which we are determined to protect at all costs.



Over 203,000 radiographic negatives on valves now in service are filed for reference. Skilled technicians, qualified by long experience, examine minutely all negatives proving material soundness of Edward Valves.

Magnetic-Electronic device checks every inch of bar to left of operator above, detects all cracks or voids, differences in hardness, chemical composition or internal structure.

Edward Valves, Inc.

Another Product

HOW TO CUT MAINTENANCE COSTS *by Proper Valve Packing*

Perhaps the greatest single item of valve maintenance today is the adjustment or replacement of packing. In good, modern valve designs other potential causes of maintenance have been largely eliminated, leaving packing as the major regular maintenance item required. Following these simple rules will allow the plant operator to drastically cut the time spent on packing maintenance:

1. PACKING SHOULD FIT PERFECTLY. Too much packing makes valve operation difficult; too little packing soon results in leakage.

An experienced man working carefully with coil packing can get proper fit in a good percentage of cases. However, the use of preformed packing, die cut to exactly fit the packing chamber, insures a perfect fit in all cases, and at a fraction of the time and trouble.

2. TWO DIFFERENT TYPES OF PACKING ARE BETTER THAN ONE. Packing in a valve chamber is subjected to two opposing requirements. First, it must be soft enough to be squeezed tightly against the valve stem and packing chamber for a perfect seal. Second, it must not be so soft that it is extruded from the ends of the packing chamber when line or gland pressure is applied.

A combination of two different types of packing rings best meets these opposing requirements. The outer rings adjacent to junk ring and gland should be reinforced for additional stiffness, while the center rings should be of a softer variety for maximum sealing effect.

3. PACKINGS SHOULD BE LUBRICATED. For easier valve operation, packing materials should have a built-in lubricant—generally Graphite or Mica. Of these two, graphite is much more satisfactory in providing easier valve operation.

4. WATCH STEM PITTING. Packing should be specially treated to eliminate electrolytic corrosion of stainless steel valve stems. In addition, if valves are to be subjected to hydrostatic tests or will be stored for a long period before installation, the packing should be waterproofed to prevent absorption of moisture and subsequent corrosion, or packing deterioration.

5. CHECK DESIGN OF VALVE. Valve design plays a very important part in determining packing life. Designs which provide an effective backseat, and remove the packing from high temperature zones stretch packing life. Correct proportions in the packing chamber are also important—avoid designs that call for extremely wide packing rings, since these tend to reduce packing life.

Operators can avoid packing problems by following one rule which insures compliance with all those listed above—to use Edward EValpack packing in Edward valves. This specially designed packing is furnished in sets designed for each specific Edward valve. Every set consists of two different types. The center rings are die moulded plastic composed of long fibre asbestos lubricated with graphite. The outer rings have the same general composition with, for additional stiffness, a woven jacket of asbestos strands reinforced by metal wires. All sets are specially treated to eliminate stem pitting and waterproofed to eliminate corrosion. They can be installed in a minimum of time and will provide the longest possible service life.

Write for Bulletin 12-R for complete information.

EDWARD VALVES, Inc., *Subsidiary of*

ROCKWELL MANUFACTURING COMPANY
1350 W. 145th STREET • EAST CHICAGO, INDIANA

GLOBE AND ANGLE STOP • FEED-LINE • BLOW-OFF • NON-RETURN CHECK • GATE • GAGE AND INSTRUMENT • RELIEF • STRAINERS

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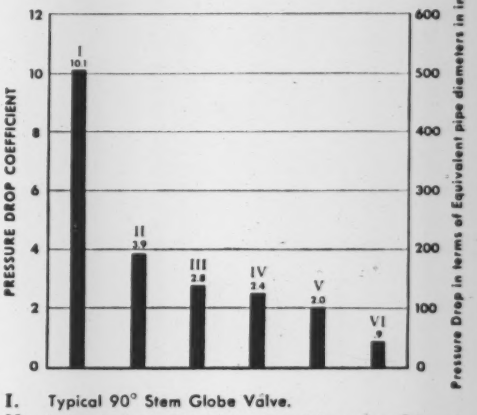
Technical Tips

Pressure Drop in Steel Valves 2 Inches and Smaller

In valves 2 in. and smaller, pressure drop is important for two principal reasons. First, obviously, from the standpoint of head loss—which may be unimportant in some instances, but have a serious economic significance in other applications. Second, pressure loss is due primarily to turbulence within the valve, which is also the principal cause of wear-producing vibration and erosion. Pressure loss in a valve therefore serves as a good index of its service life, other factors being equal.

The chart below, based on tests in the Edward laboratories, shows the pressure drop characteristics of various types of valves, with an elbow fitting included for purposes of comparison. These are given in terms of pressure drop coefficient and pressure drop in equivalent pipe diameters. In calculating these latter values the pressure drop coefficient of f = .02 for standard weight pipe was used.



I. Typical 90° Stem Globe Valve.
II. Inclined stem, screwed in seat globe valve. Edward Fig. 444, 448, 631.
III. Inclined stem, integral seat globe valve. Edward Fig. 2224, 931, 948.
IV. Typical small gate valve. Seat diameter 70 per cent of pipe diameter.
V. Angle stop valve. Edward Fig. 445, 449, 949.
VI. Elbow, screwed or socket welding end.

The user can readily calculate the equivalent length of pipe from the standpoint of pressure drop for certain small valve types with this chart. For example, a 1 in. inclined stem globe valve with integral seat will have a pressure drop equivalent to 120 in. or 10 ft. of 1 in. pipe, and the 2 in. size of the same valve will have a pressure drop equivalent to 240 in. or 20 ft. of 2 in. pipe.

The superiority of inclined stem construction for globe valves in this size range is obvious—note that the integral seat Y-type globe valve has a pressure loss 72% less than the 90° stem type globe valve. The pressure loss characteristics of Y-type globe valves compare quite favorably with gate valves. The tighter shut off obtained, ability to throttle and other advantages realized with these globe valves, make desirable their use in many applications.

Edward

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Get this NEW BOSTON Gear®

SPROCKET CATALOG

SUPPLEMENT SC-2

Every sprocket user will want this new, up-to-the-minute 48-page book of buying information on . . .

- **STANDARD SPROCKETS — all types**
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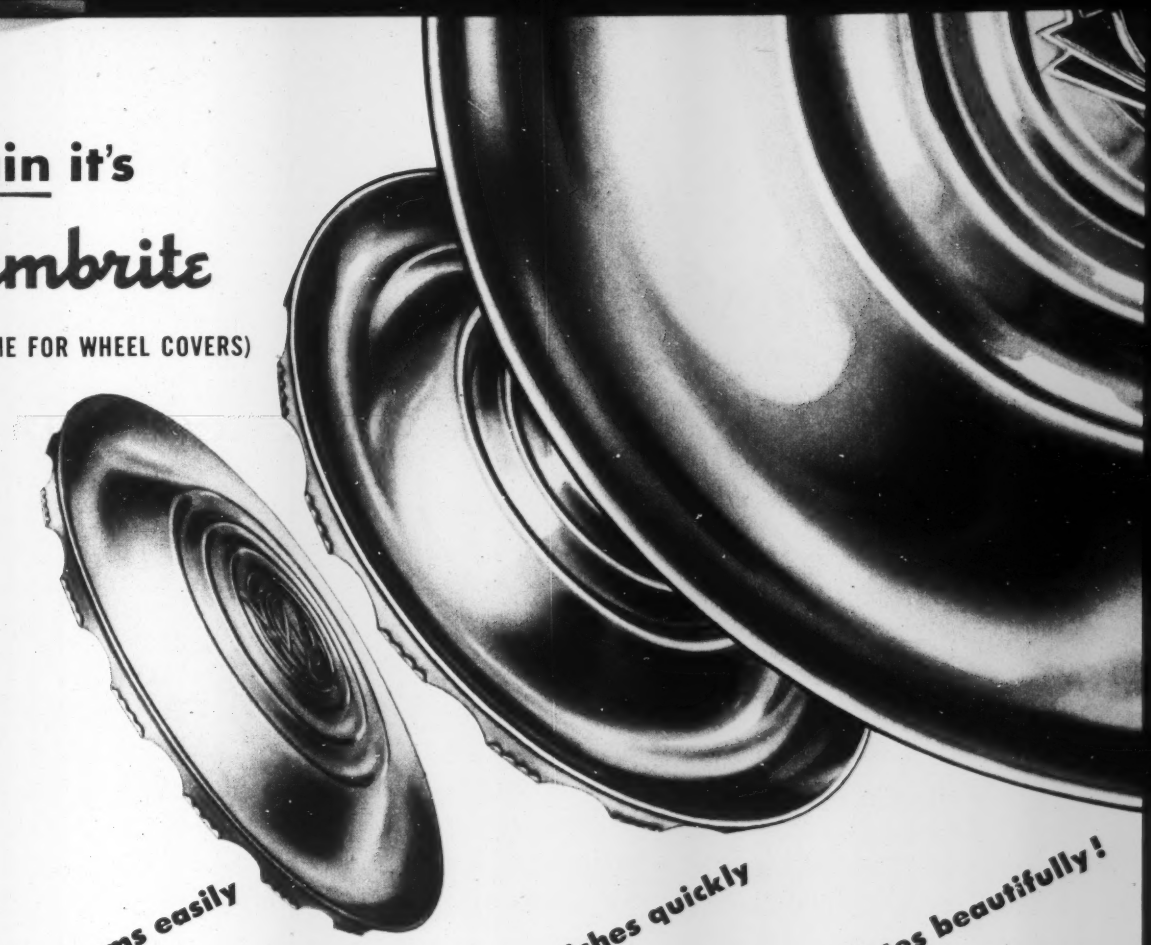
again it's Formbrite

(THIS TIME FOR WHEEL COVERS)



● it forms easily ● polishes quickly ● plates beautifully!

Canadian Motor Lamp Co., Limited, Ford, Ontario, is a large automotive parts supplier. When Canada's "Big Three" turned to full wheel covers in place of hub caps for many '53 models this supplier, suddenly facing a new set of production problems, turned to Formbrite*, exceptionally fine-grain Anaconda Brass. Here are the reasons:

1 Previous experience in manufacturing large quantities of chromium-plated brass hub caps made of Formbrite indicated that polishing operations could be reduced as much as 50%.

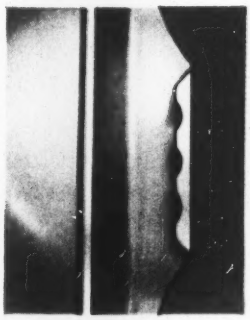
2 Formbrite had demonstrated its remarkable ductility for press operations—taking sharp, clean-cut, ornamental die impressions.

3 Formbrite was harder, stronger, springier and more scratch-resistant than ordinary drawing brass . . . desirable characteristics for the service involved.

4 Important, too, was the fact that Formbrite would provide the fatigue-resisting springiness to the gripping fingers that hold the cover to the wheel.

Now in full production on the new wheel covers, Canadian Motor Lamp's appraisals proved 100% correct. Maybe *you're* missing something by *not* using Formbrite. Write for Publication B-39, addressing The American Brass Company, General Offices, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Limited, New Toronto, Ontario.

*Reg. U. S. Pat. Off.

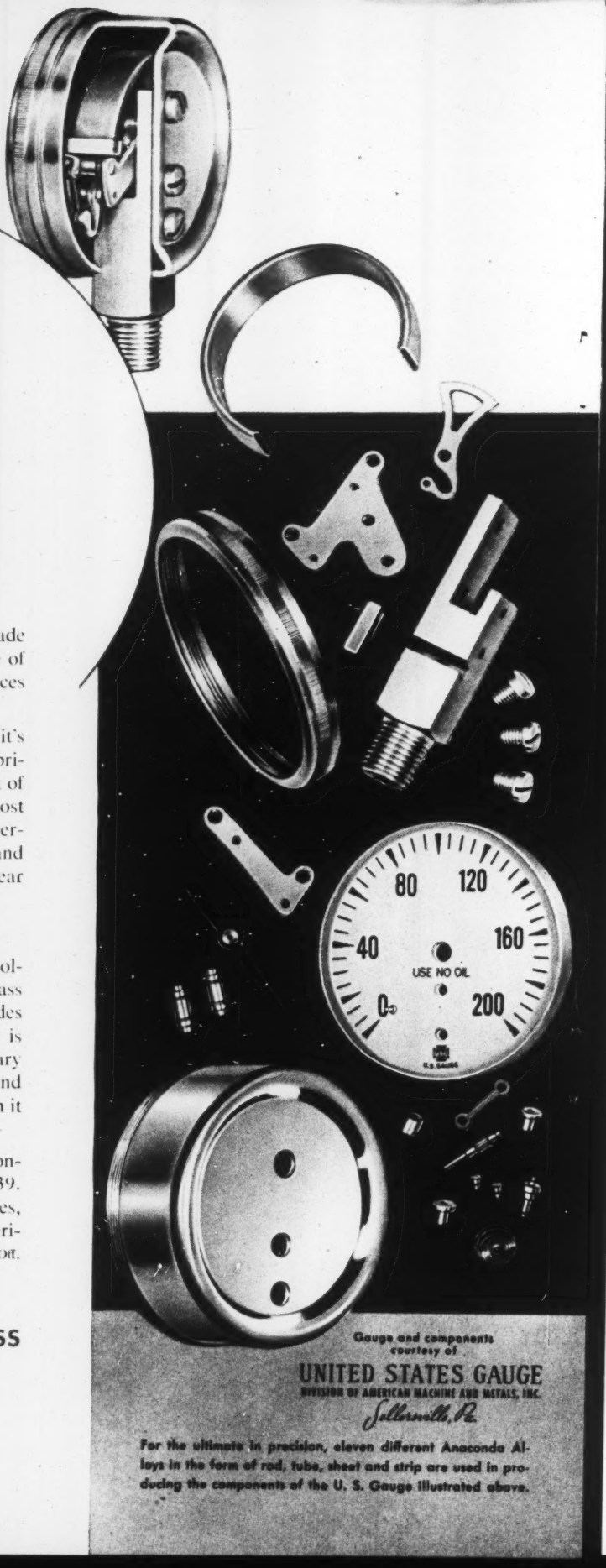


Shown above is one of the 16 sets of gripping fingers which hold the 15" diameter wheel cover to the rim. The metal is yellow brass, .024" thick, supplied in coil as Formbrite.

Formbrite DRAWING BRASS

An ANACONDA product made by The American Brass Company

PRESSURE!



It's big business at U.S. Gauge where **brass belongs**

At Sellersville, Pa., millions of pressure gauges are made each year—for every type of industry—to every degree of accuracy—and for pressures ranging from a few ounces per square inch up to 100,000 pounds.

With each gauge a precision instrument unto itself, it's quite a job to maintain the high standards of routine fabricating procedure on each of its many components. Part of it depends on having just the right copper alloy in the most satisfactory combination of chemical and physical properties. That's where teamwork between U. S. Gauge and Anaconda Metals has been clicking day after day, year after year.

and now—something NEW has been added . . .

U. S. Gauge is now using Formbrite* for many of its "polished and lacquered" and chromium plated solid brass gauge cases. Formbrite, with its superfine grain, provides a surface far superior to ordinary drawing brass. It is stronger, harder, more scratch-resistant than ordinary brass, yet retains remarkable ductility for forming and drawing. Best of all, Formbrite is a real time saver when it comes to finishing operations.

Want to know more about this "premium product at a non-premium price"? Write for Anaconda Publication B-39. Address: The American Brass Company, General Offices, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. *Reg. U. S. Pat. Off.

Formbrite DRAWING BRASS

An **ANACONDA** Product

Made by The American Brass Company

Gauge and components courtesy of

UNITED STATES GAUGE

DIVISION OF AMERICAN MACHINE AND METALS, INC.

Sellersville, Pa.

For the ultimate in precision, eleven different Anaconda Alloys in the form of rod, tube, sheet and strip are used in producing the components of the U. S. Gauge illustrated above.

Since 1888-65 years of progress

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for every requirement

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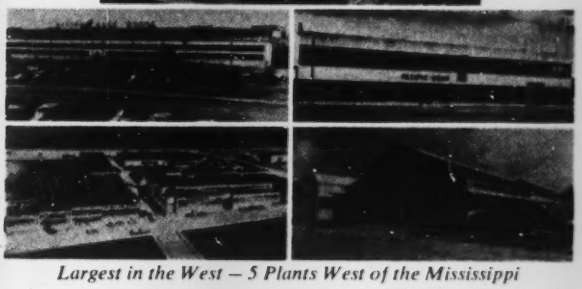

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In hydraulic pumps

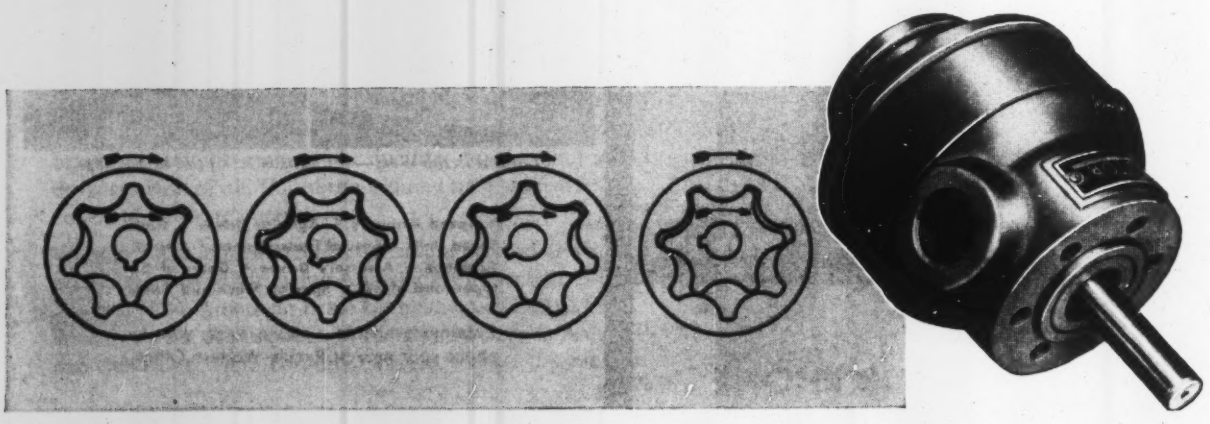
GEROTOR

is more than a name . . .

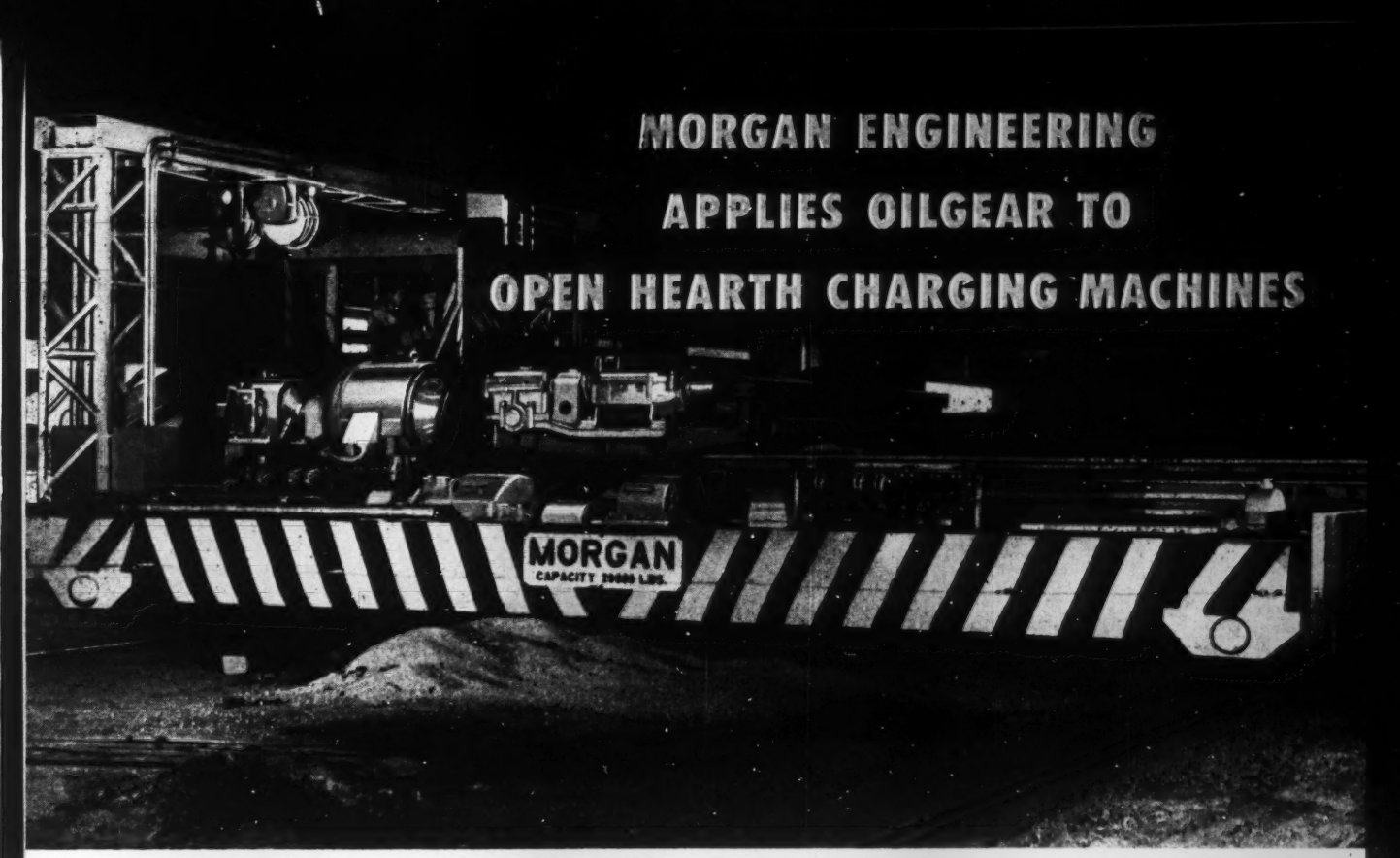
it's the principle of the thing!

The unique Gerotor principle operates with high volumetric and mechanical efficiency. Both gear-shaped Gerotor elements revolve in the same direction at low relative speed, resulting in less wear, longer life. Continuous fluid-tight engagement means less slippage, more uniform flow. See relative advance of teeth and spaces below.

Gerotor hydraulic pumps are engineered for pressures up to 1000 p.s.i. continuous duty; in some sizes, up to 1200 p.s.i. continuous and 1500 intermittent. Deliveries range from .4 g.p.m. at 1800 r.p.m. to 40 g.p.m. at 1200 r.p.m. Plain, base or flange mounting. Write for pump catalog. GEROTOR MAY CORP., P. O. Box 86, Baltimore 3, Md.



GEROTOR hydraulic pumps & motors



MORGAN ENGINEERING APPLIES OILGEAR TO OPEN HEARTH CHARGING MACHINES

Gains Longer Life, Greater Visibility, Safety and Simplified Design

It has been said that for a number of years very few improvements have been made in open hearth charging machines used in steel mills. Here too a consideration of Oilgear Fluid Power equipment led to some valuable and important progress.

The Morgan Engineering Company, a leading manufacturer in the field, decided that much could be gained by the use of oil hydraulics and designed its 10-ton charging machine accordingly. Morgan uses the following Oilgear Fluid Power equipment: a hydraulic pump with a volume of 60 gallons per minute at 1700 psi pressure; 2 hydraulic cylinders for the hoist; one cylinder for the peel clamping device; two 4-way control valves located near the pump operated in turn by two pilot valves in the operator's cab; and a cam operated relief valve on the peel clamping device.

The company gained the following advantages: on the hoist, the conventional large hoist motor with its reduction unit is eliminated giving the operator maximum visibility and of course surer operation. The hydraulic cylinders used eliminate the conventional crank motion used hitherto exclusively.

The peel clamping device is actuated by one hydraulic cylinder, felt to be a definite improvement. It was found that hydraulic clamping is adequate by itself and the usual locking device was eliminated. More important, hydraulic clamping prevents oscillation of the boxes while the peel is being rotated and this prolongs the life of both peel head and boxes.

The cam operated relief valve is a safety measure, preventing the operator from lifting the box until the locking rod has been correctly located in the box head well.

Since this application has proved so satisfactory, the Morgan Engineering Company has applied Oilgear Fluid Power Equipment to other types of charging machines, to hot saws, inverted and portable strippers as well.

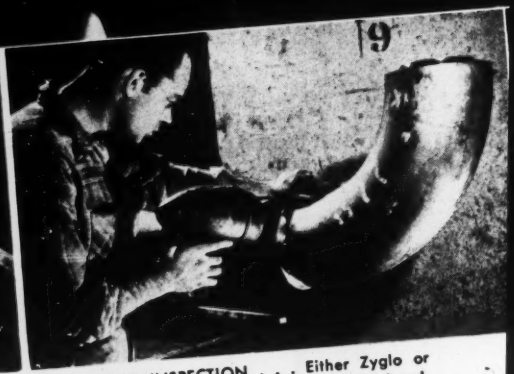
Designers should bear in mind the advantages cited above are in addition to the fundamental Oilgear advantages of flexibility, wide range of power, infinitely and steplessly variable speed range, unlimited ratios, smooth cushioned acceleration and shockfree hydro-dynamic braking, simplified and accessible hydraulic design well ahead of J.I.C. standards, a range of application from the handling of the most delicate and fragile webs up to the most massive power requirements. You are invited to submit your problem to Oilgear. It will cost you nothing to do so; it may prove to be one of the most profitable steps you have ever taken. THE OILGEAR COMPANY, 1570 W. Pierce St., Milwaukee 4, Wisconsin.

OILGEAR

OILGEAR

1. THE LINE-UP . . . After precision positioning of butts the joint is tack welded to hold in place during the welding of the initial bead by the K-Weld process. This new technique entails the use of an inert gas under controlled pressure on the inside of the piping.

2. INITIAL BEAD IN K-WELD . . . Only the initial bead is laid by the K-Weld process. It eliminates the need for a backing ring, permits the complete penetration required for critical high-pressure, high-temperature power piping being installed today.



3. FIRST INSPECTION . . . Either Zyglo or X-ray can be used to inspect the K-Weld bead. Elimination of the backing ring removes the stress raising condition at the weld root which can produce flaws either as a result of thermal effects of subsequent weld layers or later severe operating conditions.

Done with mirrors . . . A conventional telescopic bore-sight plus a mirror positioned at the weld permits visual inspection of the K-Weld root. Note smoothness and absence of any icicles which might create local turbulence or break off and damage equipment.

..K-WELD

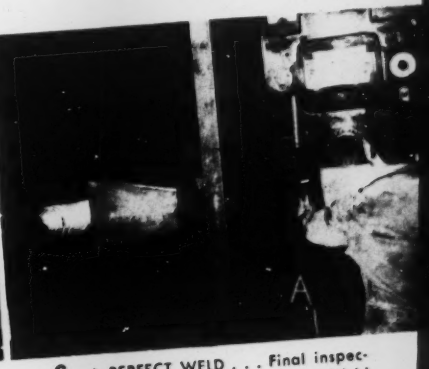
a picture story of the new welding technique that...

- **assures complete penetration without backing rings**
- **applies to all power piping materials**
- **for use in shop and field fabrication**

From rockets to power piping is largely the story of Kellogg's new K-Weld process, a welding technique that assures a sound root weld in the fabrication of piping. It stems from Kellogg's initial work in the production of thin-wall rockets where shielded-arc welding is a requirement in fabricating stainless steel rocket tubes. How this technique has been developed and extended to the fabrication of critical high-temperature, high-pressure piping is detailed in the accompanying picture story.

4. COMPLETING THE WELD . . . Conventional shielded metallic arc welding is employed to complete the weld which can be done by any competent welder qualified for this class of work.

5. STRESS RELIEVING . . . The completed weld after grinding is ready for heat treatment in the customary manner. An additional advantage of K-Weld is that elimination of the backing ring materially aids in the interpretation of radiographs.



6. A PERFECT WELD . . . Final inspection is made of the weld. Here K-Weld has been proved to be extremely useful in eliminating the root cracking associated with austenitic welding . . . providing a completely satisfactory weld.

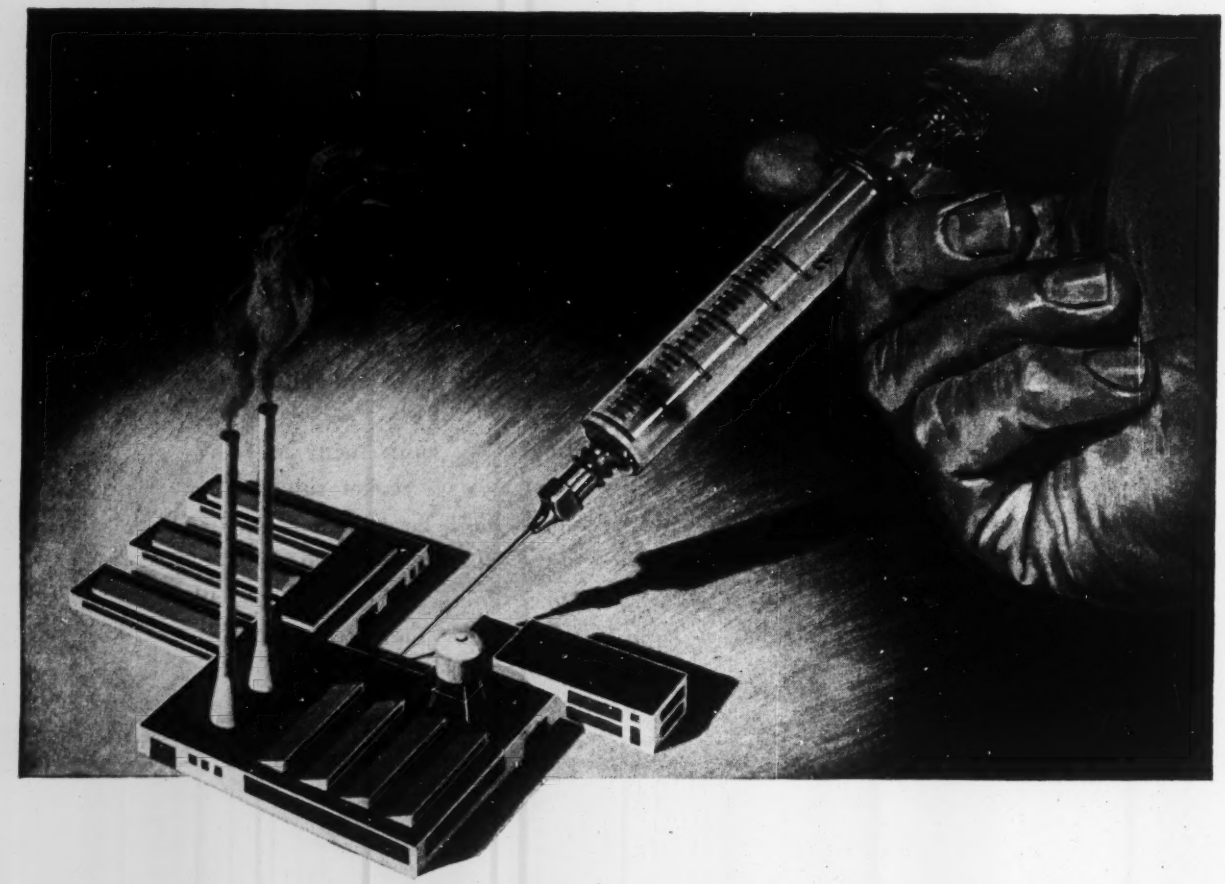
These leading companies are among the many major producers of power who use M. W. KELLOGG POWER PIPING . . .

- Houilleres Du Bassin Du Nord Et Du Pas-De-Calais (France)
- Hydro-Electric Power Commission of Ontario (Canada)
- Indiana & Michigan Electric Co.
- Interbrabant (Belgium)
- Long Island Lighting Co.
- Metropolitan Edison Co.
- Mexican Light & Power Co. (Mexico)
- Monongahela Power Co.
- New York State Electric & Gas Company

OTHER FABRICATED PRODUCTS including: Pressure Vessels . . . Vacuum Vessels . . . Fractionating Columns . . . Drums and Shells . . . Heat Exchanger . . . Process Piping . . . Bends and Headers . . . Forged and Welded Fittings . . . Concrete and Radial Brick Chimneys

FABRICATED PRODUCTS DIVISION
M. W. KELLOGG COMPANY

KELLOGG — A DIVISION OF PULLMAN INCORPORATED



Vitamins That Make Production Grow

Perhaps, like many producers these days, you've found today's heavier demands are asking more from your equipment than it can produce.

Consider how one typical company injected new productivity into *its* operation:

This was a soap processor who needed extra production and new fuel economy for a process involving crude with a high salt content. Development of a specially-built still pot of economical clad steel eliminated need of multiple distillation . . . reduced fuel and maintenance . . . speeded up heating . . . ended corrosion . . . provided structural strength to withstand vacuum—*and cut first equipment cost, too.*

What makes this story significant is that it resulted from a progressive planning method followed by certain Equipment Builders.

These specialists bring leading engineers, designers, and materials suppliers into the planning of your equipment. Each factor affecting performance *is thought out by a specialist in that field.* And in such planning, you'll find these builders turning to Lukens for its knowledge of materials, as well as its wide range of low-cost clad steels.

Even with new equipment often difficult to get these days, we know builders who can recondition what you have for better performance, better profits. Write us today, explaining your need. Manager, Marketing Service, 402 Lukens Building, Coatesville, Pennsylvania.

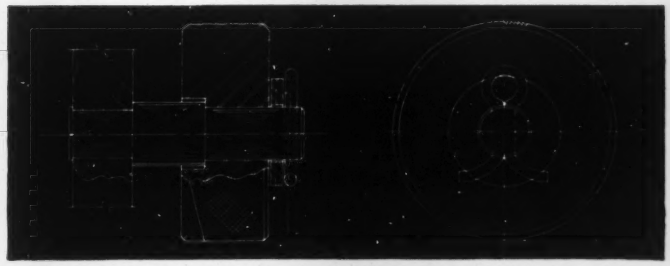
LUKENS

World's Leading Producer of

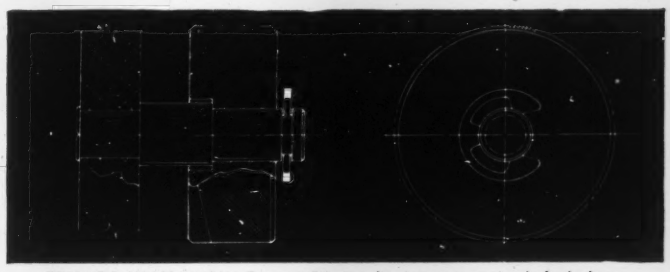
SPECIALTY STEEL PLATE • PLATE SHAPES • HEADS • CLAD STEELS

LUKENS STEEL COMPANY, COATESVILLE, PA.

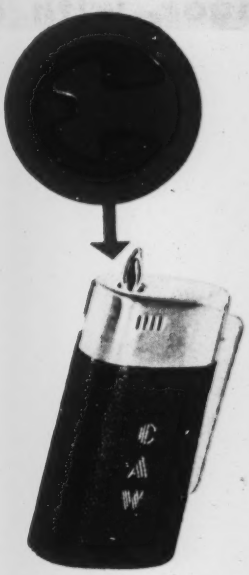
WALDES TRUARC RINGS REPLACE COTTER PINS...
SAVE 44% IN LABOR AND ASSEMBLY COSTS



COTTER PIN WAY: Flint wheel shaft in lighter assembly requires cotter pin, washer. Difficulty in drilling perfect hole causes rejects. Assembly is slow, costly.



TRUARC WAY: Waldes Truarc "E" ring fits into groove in shaft; locks assembly securely for life. Groove is quickly, easily cut... assembly is simple, speedy.



Brown & Bigelow, St. Paul, Minn., saved *$6.95 per thousand units* by incorporating Truarc Rings in the design for the REDI-FLAME compressed gas desk lighter! In spite of greater initial cost of Truarc Rings as against cotter pins, they were able to cut machining and assembly costs drastically—for an overall savings of 44%!

Redesign with Waldes Truarc Rings and you too will cut costs. Wherever you have a fastening problem...wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Truarc Ring designed to do a better job of holding parts together.

Waldes Truarc Rings are precision-engineered...quick and easy to assemble and disassemble. They can be used over and over again.

Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

COMPARATIVE COSTS

Cotter Pin Way		Truarc Way	
Material	***$ Per M***	***Material***	***$ Per M***
Shaft	.48	Shaft	.35
Cotter pin	.46	Truarc ring	8.68
Washer	1.50		
	2.44		9.03
Labor		***Labor***	
Shaft	10.22	Shaft	2.27
Washer	.72		
Assembly	9.28	Assembly	4.41
	20.22		6.68
TOTAL	$22.66	TOTAL	$15.71

TOTAL SAVINGS WITH TRUARC RINGS: $6.95 or 44%

For precision internal grooving and undercutting... Waldes Grooving Tool.

SEND FOR NEW BULLETINS

WALDES

TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 2,382,947; 2,382,948; 2,410,952; 2,420,921; 2,420,341; 2,439,785; 2,441,846; 2,459,165; 2,483,380; 2,483,383; 2,487,802; 2,487,403; 2,491,308; 2,509,081 AND OTHER PATENTS PENDING.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send engineering specifications and data on Waldes Truarc Retaining Ring types checked below. ME975

- ☐ Bulletin #5 Self-locking ring types
- ☐ Bulletin #6 Ring types for taking up end-play
- ☐ Bulletin #7 Ring types for radial assembly
- ☐ Bulletin #8 Basic type rings
- ☐ Send me information about the Waldes Grooving Tool.

Name_____

Title_____

Company_____

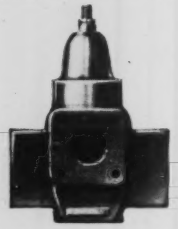
Business Address_____

City_____ Zone_____ State_____ 3678

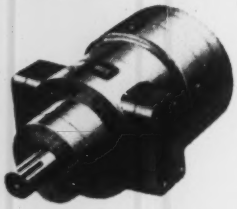
BUILT TO TAKE IT

longer, with less maintenance, at pressures up to 5000 psi

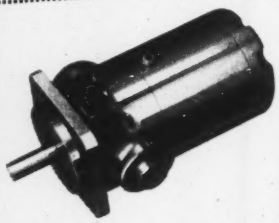
SURGE-DAMPING CONTROLS
Industrial and Aircraft Types
Eliminate Destructive Hydraulic Pressure Shock
¼" to 1" Sizes
For Pressures to 5000 psi
Catalog VS-1-A



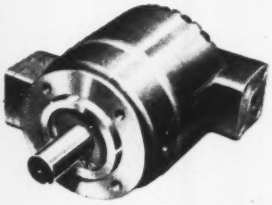
Direct-Operating PRESSURE CONTROLS
⅛" to 1½" Sizes
For Pressures to 2000 psi
Catalogs VRD-1 through VRD-8



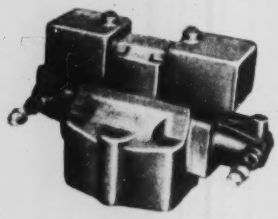
High-Pressure Axial-Piston PUMPS
Constant or Variable Volume
For 2500, 3000 and 5000 psi Circuit Needs
3.5 to 35 gpm Capacities
Catalogs P-4 through P-4-10



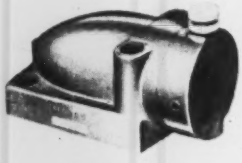
High-Torque Axial Piston FLUID MOTORS
Torque Ratings 13.8 to 112 inch-pounds per 100 psi (about 3 to 180 hp maximum)
For Pressures to 5000 psi
1500 to 3000 rpm
Catalogs FM-1, FM-2, FM-3-A



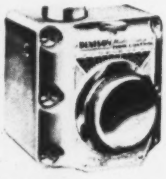
Dual-Purpose, Vane-Type PUMP/MOTOR
Ready for either pump or motor use without change
Shaft rotation in either direction
Four Sizes, 11 Models
Pumping Capacities: 3 to 82 gpm.
Motor Torque: 13 to 257 inch-pounds per 100 psi. Pressures to 2000 psi.
Bulletin P-5



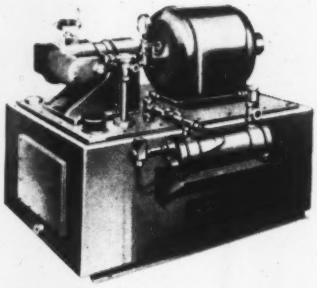
DIRECTIONAL CONTROLS
Manual, Mechanical, Electric or Pilot Control. ¼" to 2" Sizes
For Pressures to 5000 psi
Catalog VD-3



PRESSURE REDUCING VALVES
¼" to 1½" Sizes
20 gpm to 65 gpm Capacities
For Pressures to 5000 psi
Catalog VPR-1



Multi-Range FLOW CONTROLS
Full-Scale Regulation—Adjustable for Varying Input
¼" to ¾" Sizes
For Pressures to 3000 psi
Catalogs VFC-1, VFC-2



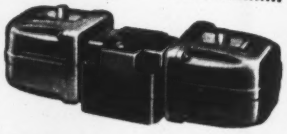
PUMPING UNITS
Constant and Variable Volume
46 Models—2 to 35 gpm Capacities
For Pressures to 5000 psi
Bulletins PU-3-A, PU-4 and PU-5

Denison HydrOILic PUMPS, MOTORS and CONTROLS

Proved in use—under many of Industry's toughest operating conditions—Denison HydrOILic Pumps, Motors and Controls are noted for their combination of high efficiency and rugged dependability.

In addition to fine performance under continuous, heavy-duty use, Denison HydrOILic Equipment offers space-saving design that simplifies circuit layout, makes installation easier, and minimizes maintenance problems.

Because so many users verify the extra value built into Denison Pumps, Motors and Controls, we continue the challenge made so often before—*let comparison prove to you* why they are first choice for so many needs of every type. Write today for full details on Denison HydrOILic Equipment to meet your requirements.



Pilot-Operated, Solenoid-Controlled DIRECTIONAL VALVES
Eliminate Spool-Sticking
¾" to 1½" Sizes, For Pressures to 5000 psi
Catalogs VD-1-1 to VD-4-2

Hydraulically Balanced PRESSURE CONTROLS
¾" to 2" Sizes
For Pressures to 5000 psi
Catalogs VR-2-B and VR-5-2

The DENISON Engineering Co.
1189 DUBLIN ROAD, COLUMBUS 16, OHIO

DENISON HydrOILics

"The Finest Money Can Buy!"

This 7-Letter Word Tells the Story

• There are many descriptive words and phrases we might use to prove the effectiveness of Zallea Stainless Steel Expansion Joints as the ideal medium to absorb thermal expansion and contraction in pipelines. But no single word has more convincing meaning . . . more significance than the simple 7-letter word . . . "*reorder.*"

Over the past 23 years, thousands of industrial organizations have expressed their confidence in our products by reordering not once, *but time and time again!*

Here's a sample of the record:

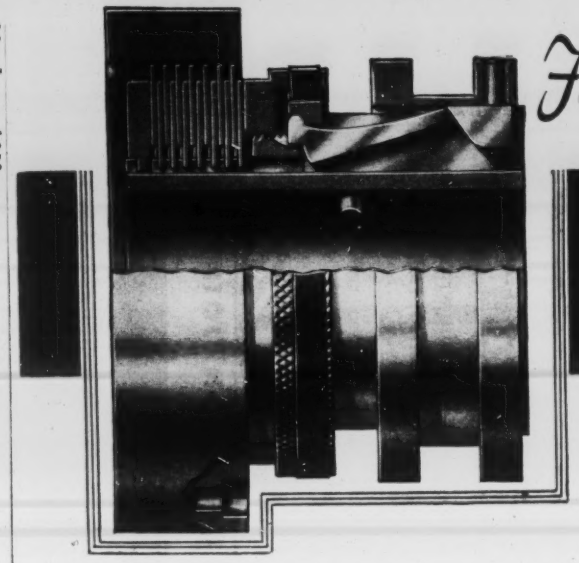
Company	Number of Orders Placed*	Since
American Viscose Corp.	79	1940
Bethlehem Steel Corp.	51	1935
Carbide & Carbon Chemical Co.	93	1936
Consolidated Edison Co.	115	1933
Dravo Corporation	53	1939
E. I. du Pont de Nemours & Co., (Inc.)	308	1934
Ebasco Services	46	1934
Hercules Powder Co.	133	1937
Koppers Co., Inc.	165	1942
Nordberg Mfg. Co.	174	1942
Sun Oil Co.	60	1938
Texas Co.	261	1938

**Including as many as 485 expansion joints in a single order!*

This acceptance is your assurance of the dependable, economical performance you'll receive when you, too, order and *reorder* Zallea Stainless Steel Expansion Joints. Why not write us *today?* Zallea Brothers, 820 Locust Street, Wilmington 99, Del.

Catalog 47 and Bulletin 351 describe the complete line of Zallea Expansion Joints and Flexible Connectors. Write for copies today.

Zallea
EXPANSION JOINTS



For **MACHINE TOOLS... MACHINERY... PRODUCT DESIGN...** *Specify*

MAXITORQ CLUTCH

There are 2 basic types of Maxitorq clutches . . . Single and Double. Above is a cut-away view of the single type . . . the double is shown at right. Each is available in 8 capacities (wet or dry) from ¼ to 15 h.p. @ 100 r.p.m. And from 13 to 788 max. working torque ft. lbs. Pulley type, Ring type, or Cut-off Coupling Driving Cups are also available.

The Maxitorq automatic overload release clutch (up to 5 h.p.) is extremely useful for protection of machine and product against accidental overload in high speed production. Special bulletin on request.

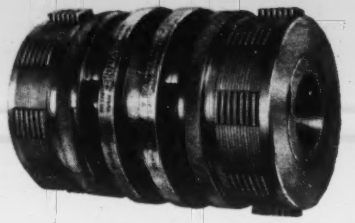
Send for Catalog No. ME-7

We hope you haven't minded turning this magazine around, but it was the only proper way to include the picture at the bottom. It clearly shows all parts of a single Maxitorq Clutch...and how easy it is to adjust it, take it apart, and assemble it...manually.

Each and every part contributes to smooth, positive, trouble-free clutch operation. The Separator Springs between each pair of inner discs keep them "floating" in neutral...preventing drag, abrasion, and heat. A Locking Plate locks all discs against the tension of the Separator Springs. The Adjusting Ring provides the means for obtaining the desired shifting pressure.

These are some of the reasons why we counted 69 machines, exhibited at the last Machine Tool Show, that were equipped with Maxitorq floating disc clutches. Send for our 50th Anniversary Catalog...and see how Maxitorq answers your problems for dependable power transmission.

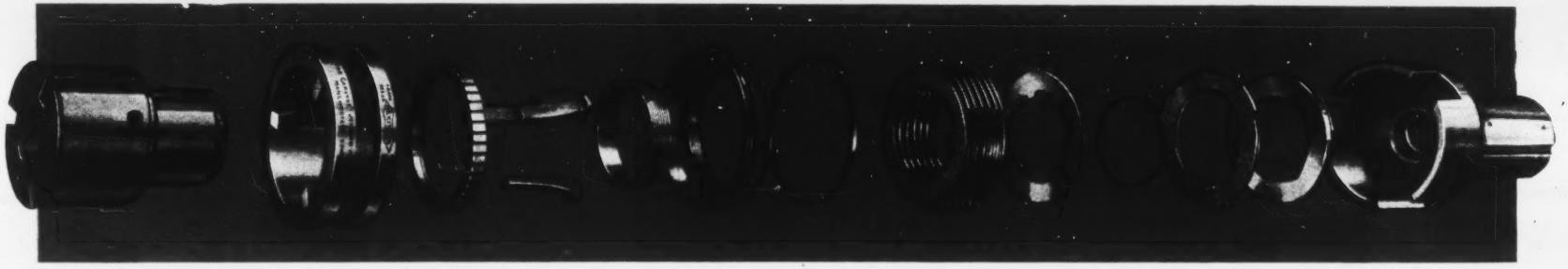
THE CARLYLE JOHNSON MACHINE CO.
MANCHESTER, CONNECTICUT



Compact, rugged construction and precise machining . . . flat, true surfaces on engaging faces of the discs . . . provide not only the exacting accuracy required in important industrial machines, but also long, profitable service life.

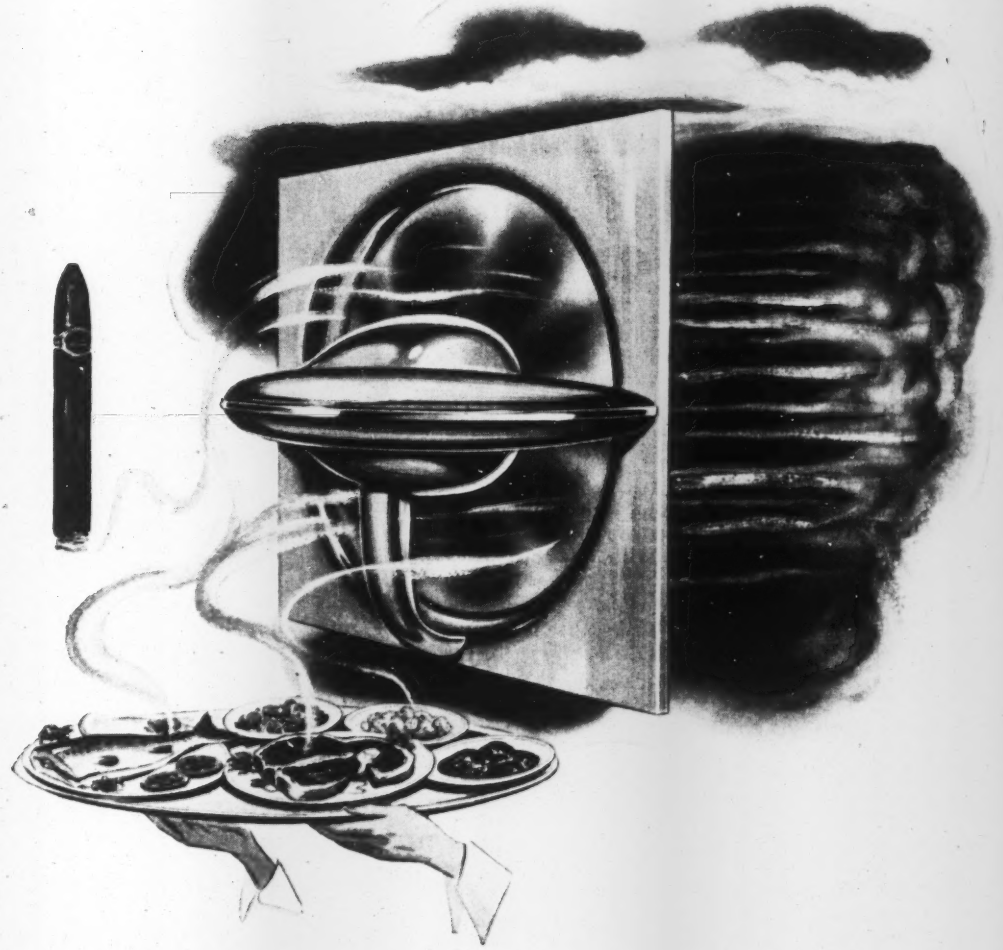
Our engineers will give you personal assistance for correct selection of the right clutch and installation for your specific requirement.

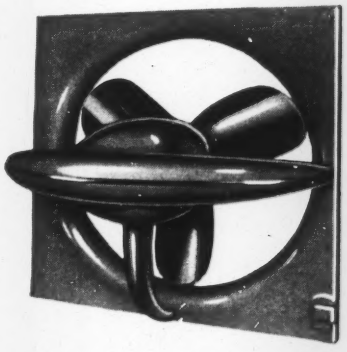
ALL ASSEMBLY, DISASSEMBLY AND ADJUSTMENTS ARE MANUAL. CLUTCHES SHIPPED ASSEMBLED ON THE BODY.



4CJ53

American Blower *Ventura Fans*





American Blower Model A Ventura Ventilating Fan. Capacities from 1000 cfm to 9700 cfm, free delivery.

Nothing, absolutely nothing, overcomes the objections to bad odors quite as well as removing them. American Blower Ventura Fans will do this job quickly, quietly and efficiently.

Their modern, streamlined styling makes them ideal for offices, restaurants, retail stores and other commercial buildings.

Ventura Fans, Air Conditioning Units and Unit Heaters are but a part of American Blower's complete line of Air Handling equipment. Write today for information or literature on any of our products.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

Division of American Radiator & Standard Sanitary Corporation

AMERICAN BLOWER

YOUR BEST BUY IN AIR HANDLING EQUIPMENT

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS

Do you have a "Problem" Fluid to be metered?

Many highly corrosive or viscous fluids previously considered unmeasurable are now accurately and easily metered with Foxboro d/p Cell. The wide acceptance and successful performance of this all-metal flow transmitter are indicated by more than 17,000 successful installations.

Simpler, less expensive to install and maintain, the d/p Cell measures the flow of "problem fluids" as easily as water, steam, or air . . . transmits pneumatically or electronically to indicating, recording, or controlling receivers. Small, compact, and mercuryless, the d/p Cell weighs less than 19 lbs. Its negligible displacement and corrosion-proof construction eliminate usual maintenance problems. Ranges: from 25" to 800" water. Working pressures to 4000 psi. Steel or Type 316 Stainless construction, or other materials as required.

If you have a difficult flow measuring problem, let us show you how the d/p Cell can solve it.

Fluids like these are no problem for d/p Cells

Liquid Latex
HCL Acid
HNO_3 Acid
HF Acid
H_2SO_4
Molten Naphthalene
Molten Phthalic Anhydride
Molten NaCL
Molten Sulphur
Raw Sewage
16% Lime Slurries
6% Paper Stock
Chlorine (gas or liquid)
Molasses
Any condensable fluid, no condensing chambers needed

THE FOXBORO COMPANY, 966 NEPONSET AVE., FOXBORO, MASS., U.S.A.

FOXBORO REG. U.S. PAT. OFF. **d/p cell**

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

COPPER TUBE and **COPPER BASE ALLOY**

Quality-controlled from ore to finished product. Made in popular sizes to give you long, dependable service. Wolverine is also an excellent source for integral finned tube (Wolverine Trufin*) to meet your specific needs. Besides round tube, Wolverine can furnish oval, square and hexagon shapes.

ALUMINUM TUBE

Made from 2 S and 3 S aluminum; 2 S in sizes ⅛" O.D. to 1⅜" O.D., nominal composition of 99% of aluminum; and 3 S in sizes ⅛" O.D. to 2¾" O.D., 97% aluminum and 1.25% of manganese.

ELECTRIC-WELDED STEEL TUBE

The same mill controls that we exercise in making Wolverine seamless tube are employed in making Wolverine Electric-Welded Steel Tube. Available in outside diameters ¼" to 3" — in analyses: SAE 1010, SAE 1015, SAE 1020, SAE 1025, SAE 1030.

STEPPING AHEAD

These tubes—carrying the distinguished Wolverine mark of top quality—are always up front.

Why are they in this leading position? What gives them their unique quality? Not men and machines alone. No, sir!

Look beyond the equipment and the guiding hands that produce these Wolverine tubes and you will realize the tireless research and development going on continuously in order that your particular tube requirements can be satisfied. We try to prepare not only for your current tubing needs but those of tomorrow as well.

We must stay ahead of the procession, ever alert to changing conditions, to be ready to meet your future needs.

You can always feel confident that Wolverine tube will lead the way toward giving you top tube performance.

WOLVERINE TUBE DIVISION
of CALUMET & HECLA, INC.

ESTABLISHED 1916

Manufacturers of Tubing Exclusively

1437 CENTRAL AVENUE • DETROIT 9, MICHIGAN

Plants in Detroit, Mich. & Decatur, Ala. *Sales offices in Principal Cities*

Export Department, 13 E. 40th St., New York 16, N. Y.

Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario.

*REG. U.S .PAT. OFF.

1½"-18 Flat Head Silicon Bronze Wood Screw. One of 7,000 Stock Items.

end corrosion with HARPER everlasting fastenings

From the day the equipment you manufacture leaves your plant, corrosion begins its work of destruction. It may be slow if atmospheric conditions alone are encountered, or rapid if salt spray, caustic chemicals or acids affect its operation.

Many manufacturers find that the small additional cost of corrosion-resistant fastenings is good insurance on their equipment. Fastenings of brass, silicon bronze, naval bronze, copper, nickel, aluminum, Monel or stainless steel last longer—prevent breakdown—improve appearance and salability.

The H. M. Harper Company is the largest manufacturer specializing in fastenings of corrosion-resistant metals. Over 7,000 items are carried in stock—one order to write—one account to keep—one bill to pay.

There is a Harper Branch office or Distributor near you with stocks ready to fill your order. Consult with Harper metallurgists and engineers on any tough corrosion problem you may be facing.

THE H. M. HARPER COMPANY
8243 Lehigh Avenue, Morton Grove, Illinois

BRASS
NAVAL BRONZE
SILICON BRONZE
MONEL
NICKEL
ALUMINUM
COPPER
STAINLESS STEEL

HARPER

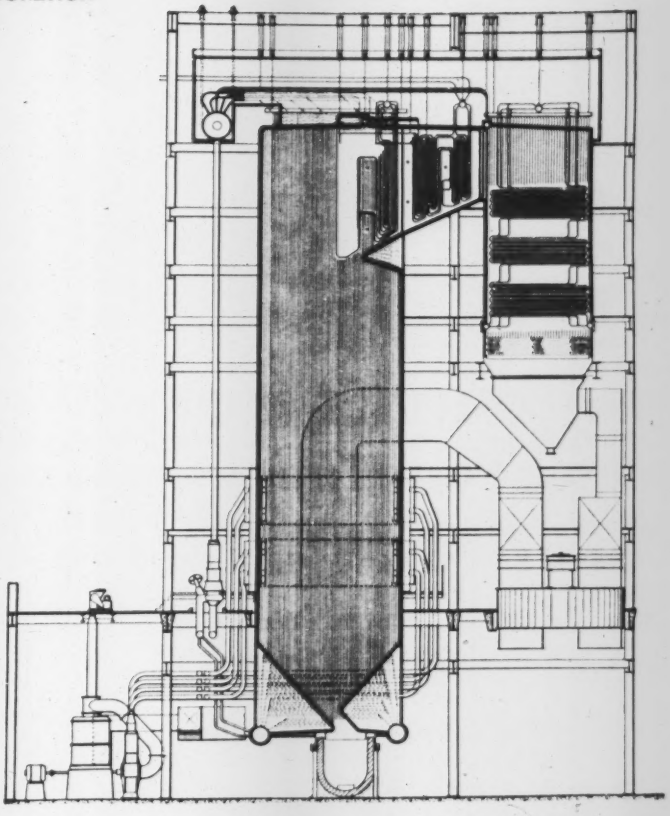
EVERLASTING FASTENINGS

SPECIALISTS IN ALL CORROSION-RESISTANT FASTENINGS

STATE LINE STATION

Chicago District Electric Generating Corporation
Commonwealth Edison System

C-E controlled circulation boilers



The C-E Unit shown above is now in process of engineering for the State Line Station of the Chicago District Electric Generating Corporation, Hammond, Indiana. State Line Station is one of the eleven generating stations of the Commonwealth Edison System. Sargent and Lundy are the consulting engineers.

This unit is designed to serve a 191,000 kw turbine-generator operating at a throttle pressure of 2000 psi with a primary steam temperature of 1050 F, reheated to 1050 F.

The unit is of the controlled-circulation, radiant type, with the reheater section located between the primary and secondary superheater surfaces. An economizer section follows the rear superheater section and regenerative air heaters follow the economizer surface.

Pulverized coal firing is employed using bowl mills and tilting, tangential burners.

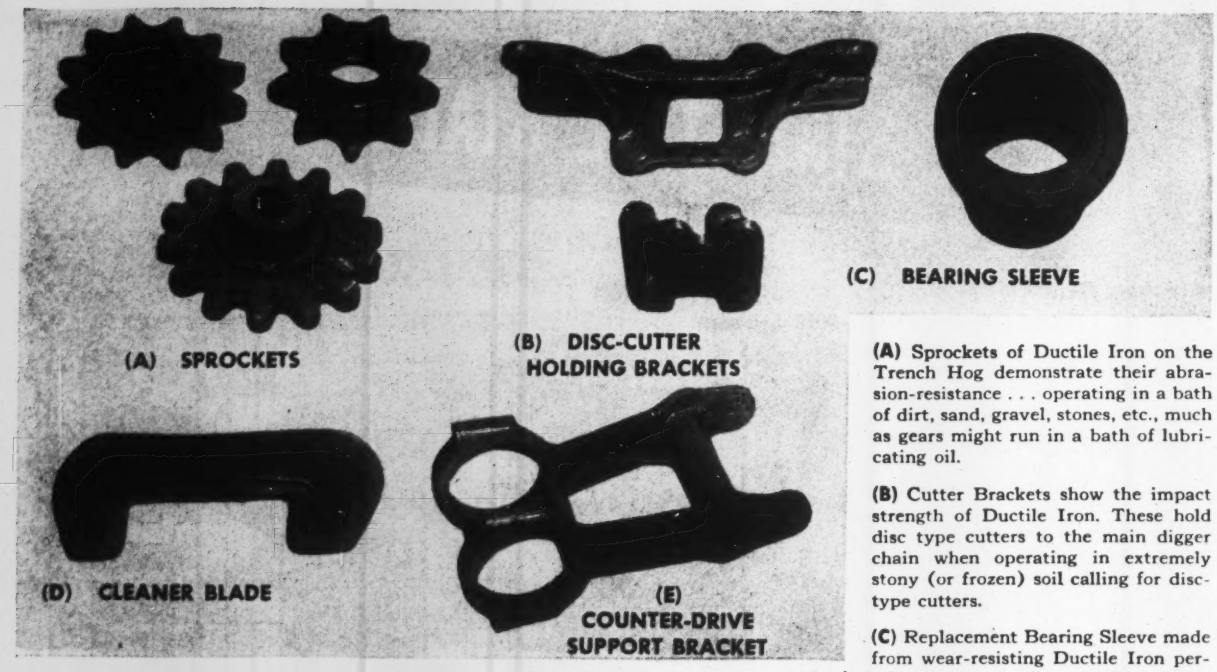
B-475

C-E

COMBUSTION ENGINEERING, INC.

Combustion Engineering Building
200 Madison Avenue, New York 16, N. Y.

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS



(A) Sprockets of Ductile Iron on the Trench Hog demonstrate their abrasion-resistance . . . operating in a bath of dirt, sand, gravel, stones, etc., much as gears might run in a bath of lubricating oil.

(B) Cutter Brackets show the impact strength of Ductile Iron. These hold disc type cutters to the main digger chain when operating in extremely stony (or frozen) soil calling for disc-type cutters.

(C) Replacement Bearing Sleeve made from wear-resisting Ductile Iron permits minimum wall section because its strength is much higher than that of gray iron, although it has the same machinability rating.

(D) Cleaner Blades of Ductile Iron mounted at regular intervals on the digger chain withstand battering and abrasion by stones and soil. These parts also prove the impact resistance of Ductile Iron.

(E) Counter-drive Support Brackets are subject to twisting action. Ductile Iron makes possible smaller, lighter brackets . . . with a higher safety factor against breakage.

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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 75 NUMBER 7

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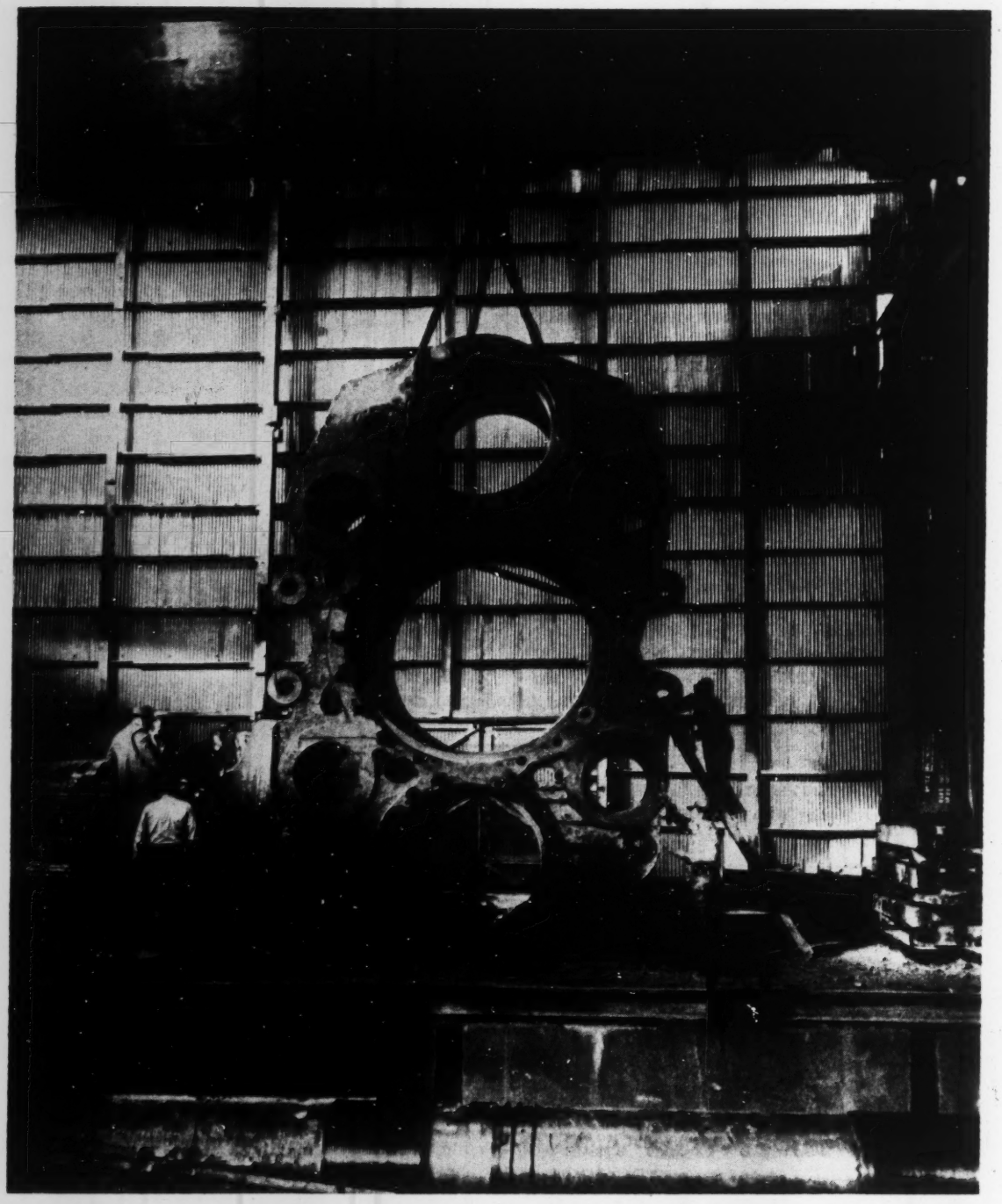
Published monthly by The American Society of Mechanical Engineers. Publ cation office at 20th and Northampton Streets, Easton, Pa. Editorial and Advertising departments at the headquarters of the Society, 29 West Thirty-Ninth Street, New York 18, N. Y. Cable address, "Dynamic," New York. Price to members and affiliates one year $3.50, single copy 50 cents, to nonmembers one year $7.00, single copy 75 cents. Extra postage to countries not in the Pan-American Union, $1.50, to Canada, 75 cents. Changes of address must be received at Society headquarters four weeks before they are to be effective on the mailing list. Please send old as well as new address . . By-Law: The Society shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B13, Par. 4). . . . Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879 . . . . Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921. . . . Copyrighted, 1953, by The American Society of Mechanical Engineers. Member of the Audit Bureau of Circulations. Reprints from this publication may be made on condition that full credit be given MECHANICAL ENGINEERING and the author and that date of publication be stated.

MECHANICAL ENGINEERING is indexed by the Engineering Index, Inc.



One Hundred and Seven Ton Cylinder Housing for 14,000-Ton Extrusion Press Recently Installed at the Lafayette, Ind., Plant of the Aluminum Company of America

(*Erected by F. H. McGraw and Company, New York, N. Y., the press was assembled in four months.* *See pages 572–574 of this issue.*)

For a Stronger and More Dynamic Society

By FREDERICK S. BLACKALL, JR.[1]

PRESIDENT, THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

I SUPPOSE that one of the things which sets our country apart as unique, or nearly so, among the nations of the world is the driving ambition which burns brightly in the souls of all Americans, regardless of their status or station, to build ever more strongly on the foundations of the past. In such an atmosphere, one forgets that in a large part of the world, the shoemaker's son is content if only he can become a good shoemaker. Not so, here, where every true American aspires to something greater than his heritage, however worthy the place to which he has been born.

Thus when I take as my theme for today's presidential address, "For a Stronger and More Dynamic Society," I cast no aspersions on the great accomplishments of our predecessors in office, nor do I imply a dim view of what our Society is, and is doing today.

The American Society of Mechanical Engineers *is*, in fact, a strong dynamic society. It is sound financially, growing in membership. It is directed by a really diligent council, chosen from its members, and administered by a staff of unusual competence. It serves an enthusiastic group of leaders, present and potential, in one of our nation's great creative professions, whose standards of performance it has done much to raise to eminence. We take justifiable pride in the broad scope, both geographical and technical, of our meetings, and the excellence of our publications. Our codes and standards, having saved our nation and its industries countless millions of dollars and who knows how many lives, have become prerequisites to our nation's defense. Our Society has made major contributons to, and given tremendous stimulus to research. The inspiration to professional, economic, and social development which active participation in ASME affairs brings to our Student Members, and especially to our Juniors who comprise more than a majority of our roster, is perhaps one of the very greatest of gifts of ASME membership. As a result of all of these things and many others, our Society has established an enviable reputation for sound leadership in engineering affairs at both the national and international levels. In brief, we have a record which evokes external acclaim and internal enthusiasm, as the attendance at this great Spring Meeting attests—but who is there among us—however fierce his pride or content with his lot—who does not wish and would not aspire to make it better!

So, in my remarks today, I should like to address myself to some of the problems which confront us and see if we cannot find within them new opportunities which will justify the addition of our names to that long list of distinguished mechanical engineers—the builders of the past—who have brought our Society to greatness.

TURNOVER IN JUNIOR MEMBERSHIP

Let us turn first to the Juniors. I am very glad, by the way, that the designation of this grade is about to be changed to "Associate Member." Of course I should be the last one to suggest that there is anything derogatory in the term "Junior." Though my parents are no longer living, I use it as an integral part of my name and signature, feeling that it is the only thing which lends them any individuality! But regardless of such considerations, there is nothing junior in the usual sense of the word about our Junior members so far as this Society is concerned. They constitute 61.8 per cent of our membership.

A large number of our sections are officered by Juniors, and a high percentage of our more technical papers, particularly in research and applied mechanics, are written by Juniors. Among the Junior memberships are found some of the most enthusiastic participants in ASME activities, all of which augurs well for the future. But the turnover in the Junior Grade is too high—or so it seems to your Council—and we are trying to ferret out the reasons why and do something about it. We are awaiting with particular interest a study and analysis of this condition which has been undertaken by a task group in the Detroit Section. Its findings should be of major help to the Society in determining appropriate changes in policy, in order better to meet the needs of this important segment of our membership. Simultaneously, our national Junior Committee is studying ways and means of supporting a stronger postcollege program to stimulate ingenuity, creative ability, and professional interest.

STUDENT TRANSFERS TO JUNIOR MEMBERSHIP

We have a problem of turnover, too, in the membership casualties at the stage of transfer upon graduation from Student to Junior Member. Unquestionably the uncertainties which confront the young engineering graduate today, due to the advent of compulsory military service, have been a real deterrent to transfer. At a time when money is short and its purposes many and various, transfer becomes one of those things which it is easy to put off to another day. And so we lose, at least for the nonce, potential memberships, and, what is far more serious, that psychological tie which tends to maintain professional interest during a formative period. I should be in favor of making it extremely easy—easier than it is now, financially at least—for the senior engineering student, facing military service, to transfer to the Junior Grade by postponing transfer fees, or permitting installment payments, or both, until the critical period is past.

Let us never forget that one of the great tasks of an effective professional society is to serve its youth.

KEEPING MEMBERS CONSCIOUS OF ASME ACTIVITIES

At the other end of the scale, however, is the lesser but none the less challenging problem of the former ASME member who, having reached the pinnacle of his career, perhaps in management or some other field not calling for constant exposure to engineering problems, loses his interest in the Society and drops the membership which he once so eagerly sought. I have been concerned over the disproportionate number of former members of ASME among my friends and business associates, now officers and directors of corporations engaged in highly technical industries, who tell me, "I used to belong to ASME, but I dropped out," and then, when I ask why, respond with the question, "Well just what does the ASME do for a fellow in my position?" I'm not sure that the fault here is not a defect in our public-

[1] President and Treasurer, The Taft-Peirce Manufacturing Company, Woonsocket, R. I.

Presented at the 1953 Spring Meeting of The American Society of Mechanical Engineers, Columbus, Ohio, April 28–30, 1953.

relations activities, which I shall touch on later, for "the fellow in his position" is certainly acutely interested not alone—or indeed so much—in what ASME can do for him as he is in what it can do for his junior executives, his staff, and his business itself. I do think it is highly important that we should keep our members conscious of ASME's work and its vital services to the engineering profession, as they grow in maturity and material success. Every effort should be made, too, in the direction of maintaining or enlisting the active participation of engineers at the administrative and management level in the meetings and other activities of the Society. To fulfil our destiny properly, we need *both* youth and experience. Certainly the Society needs the services of strong leaders of vision with top-flight administrative ability. The presence of men of this stamp in Council and the national offices will not only strengthen our Society, but will tend to attract and hold the membership of their peers. It is something which should be borne in mind in connection with your annual nominating activities. The Nominating Committee receives too few suggestions of this caliber and will welcome the widespread proposal of men of high standing for nomination to Society office.

I have mentioned the importance of public relations in this particular. When the man at the top of a machine-tool business, for example, wonders what ASME does for him, there's something wrong with our techniques of explaining our accomplishments to the public. I am glad to tell you that the Executive Committee will give early consideration to a plan for broadened public relations, consistent with the purse and purposes of our Society.

IMPROVING ASME PUBLICATIONS

As one who has had a certain modicum of editorial experience, I have a special interest in, and a profound respect for, our great technical journal, MECHANICAL ENGINEERING. Its editorial policy has always been, as it should be, on a high plane, and it ranks as one of the leading engineering periodicals of the world.

It is important, however, that we should keep MECHANICAL ENGINEERING in a position of eminence and, if possible, broaden its influence, and I should like to offer a few comments to that end. It would be a gross misconstruction of my remarks to infer, from what I am going to say, any adverse criticism of past editorial policy. It has served, and is serving its purpose admirably. But I am looking ahead, not backward, and perhaps even trying to peek over the horizon a bit.

Times and reader-habits change. Ponder the fate, for a moment, of some of the great magazines of yesteryear—giants in their day—which suddenly vanished into oblivion, because, perhaps, they lost the feel of the public pulse.

Not all of us here are too young to remember, for example, *The Literary Digest*, acknowledged news leader of its day. *Time* and *Newsweek* swept it into the vale of forgotten papers. I all but wept when the old and only original *Life*—perhaps the greatest of all journals of wit—went down. But *The New Yorker* must be more responsive to the times—I never miss a copy! This is not to say that MECHANICAL ENGINEERING is moribund. Far from it. But I think its purposes need redefinition. If we clearly understand and agree upon its objectives, perhaps we may discover that their attainment would be furthered by some restyling of its content, its editorial policy, even its type-face and format. At least we should make it our business to take a fresh look often enough to insure that we do not lag in the publishing parade.

What *are* the objectives of MECHANICAL ENGINEERING? Just to reprint or brief papers of topical engineering interest, already presented before audiences which are open to press and public, and to provide a page or two of current news items regarding Society activities? Maybe so—but, in that case, hadn't we better speed up the process? Any really "hot" subject will be fully reported by the commercial journals as soon as the paper has been delivered orally. Somebody has said that the only reason *The Literary Digest* died was that it printed all the news a week late!

Or should MECHANICAL ENGINEERING, as I somehow think, hitch its wagon to a star and seek to be the one recognized mouthpiece and monthly source of technical news of the mechanical engineering profession of our nation? This would involve an increased outlay for editing and printing. For one thing, it would probably necessitate a greater proportion of staff writing and reporting, and if that sort of thing is going to be good, the people who write it will come high. But I think a better balance between top-grade reprints of papers and top-grade technical reporting would make for a better magazine, one which would command more attention, one which would speak with more authority. Such a magazine might develop and hold enough additional memberships more than to defray the added expense involved. And I see no reason whatever why a broad circulation beyond the confines of Society membership should not be sought actively, if the editorial content and reader-appeal would justify the subscription price. Such a policy would incidentally earn increased advertising revenue. And how better can we carry the story of our profession's and our Society's accomplishments to the public? I am not sure of the answers to all of these problems, gentlemen, but I assure you that they are receiving consideration by your Publications Committee, your publications, editorial, and management staffs, and your President. We hope to have a report by the time we next meet in Los Angeles from a special task committee, which has been appointed to explore these matters. In this effort to build a greater MECHANICAL ENGINEERING, we urgently need your ideas and suggestions.

IMPROVING ASME MEETINGS

The horizons of mechanical engineering have been expanding ever since the founding fathers first joined hands in 1880. The rate of expansion has accelerated so greatly of late that it brings with it a host of problems, any one of which could preempt the time allotted to an after-dinner speaker—and then some! Among them, however, there is one of immediate concern here, and that is, how to meet the problems of an expanding technology in our meetings programs and in the organization and activities of divisions. The Board on Technology is preparing a comprehensive plan for reshaping our national program and will report at the Los Angeles meeting in June. Similarly the Organization Committee is attacking the problem of providing the best possible outlet for creative thinking in the Professional Divisions. The latter is of paramount importance if we are to avoid the risk of that biological phenomenon known as parthenogenesis—in our case, that is, the splintering off from the main body of specialized groups to form a heterogeneous group of new societies. In my view, such a trend would be doubly unfortunate at a time when genuine progress is being made through EJC and otherwise to meet the demand for greater unity within and among the engineering professions. Every possible effort should be made in our publications policy and meetings programs to meet the specialized needs of the professional groups. We should take care, in this process, however, not to erect new barriers which would render any member of the Society ineligible to participate in any or all fields of activity which may enlist his interest. No professional division should develop the exclusiveness of a craft guild, nor should our Society forget that among its expressed objectives are to foster engineering education (which I presume to include adult education), and to promote the intercourse of engineers

not only among themselves, but with allied technologists. Our Society will be stronger and more dynamic if the interchange of ideas and social contacts among its members so welds individuals into a professional unity that its collective ability can be directed into all manner of useful channels.

ASME ROLE IN RESEARCH

The expansion of engineering horizons makes it important, too, that the Society's research program be administered wisely and with discretion. Our problem here is not to compete, but rather to stimulate private and corporate research. There are, however, certain fields of broad and general interest, though they may be more pertinent to one professional division than another, to which a society-sponsored research program is especially suited. An editorial in the March, 1953, issue of MECHANICAL ENGINEERING touches on this point and quotes Dr. Vannevar Bush, who suggests as particularly appropriate examples what he calls "Background Research," such as steam tables, the properties of gases and metals, the effect of temperature on physical properties of structural materials, etc. ASME should be alert not to overlook its opportunities, or indeed its obligations in the newer fields of mechanical engineering activity as they come into focus. The challenge of the atomic age is but one example.

IMPROVING SECTION MEETINGS

Of course, the great opportunity for stimulating creative interest and accomplishment by and among engineers is at the grass roots. Here is where our Society will flower or wither on the vine. Every possible step should be taken to assist the sections in developing interesting meetings and interest *in* meetings. In this connection, it is of paramount importance that there be the utmost co-operation between the section officers and the officers of the professional divisions, particularly at the program-making level. There has been a dangerous tendency in recent years to concentrate professional division activities to an increasing extent either in the New York meeting or at major meetings of the professional divisions. As a result it is seldom possible for a member, especially if he has considerable breadth of interests, to hear all of the papers and discussions which he would like to at the Annual Meeting. Inevitably conflicts arise. Furthermore, the message of the major meetings of the professional divisions fails to reach large numbers of men who are unable to or do not feel justified in spending the time and money necessary to attend them, but who, nevertheless, may have a real interest in the subjects under discussion. A conscientious effort should be made, in my judgment, to decentralize the presentation of papers of professional character.

Perhaps we should adopt some such plan as that followed by The Institution of Mechanical Engineers in Great Britain. Any British engineer who wishes to present a paper at a national meeting in London must be prepared to duplicate the presentation at six other local meetings in the provinces. There might be some merit to encouraging the presentation of technical papers before a sectional meeting or a local professional division meeting before they are presented before one of the national meetings of the Society. This would provide opportunity for the author to measure the impact of his remarks on a trial audience, so to speak, and would assist him in perfecting the paper for national presentation and perhaps publication.

It was largely in order to permit a greater measure of co-operation between the sections and the professional divisions that the Council recently voted unanimously to provide additional funds, where necessary, through a more liberal formula for section activities. As between curtailment of meetings and programs, for which there is a demonstrated demand, and curtailment of funds, there can be no question—within practicable limits, of course. That is why, furthermore, the Society has provided, at the expense of the national treasury, seven lecturers—seven outstanding technical leaders who are accomplished speakers, who are available to you—ready and willing to address your section, wherever it may be, upon request of and by arrangement with the national office. Many other avenues of assistance are open to you through Mr. Hartford, Mr. Schier, Mr. Davies, and other members of our staff in developing a more compelling and dynamic sections program. Use these facilities—but remember, too, that the greatest success and the greatest rewards will come from the energetic organization of your own efforts at the sectional and regional level. Charity begins at home!

While discussing sectional and regional activity, I want to tender my apologies for my inability to visit every section or even a majority of them all during my brief term in office. However, last year, the Council clearly laid down the law for the President of the Society in this particular, feeling, quite properly, that the administrative complexities of a far-flung organization of 38,000 members required executive attention of continuing and concentrated character, which a heavy speaking program simply would not permit. Thus, if I fail to get around to see your section this year, please believe me when I say that I am trying to work more effectively in your section's interests at headquarters and elsewhere.

THE SOCIETY'S STAFF

In conclusion, I want to say a word about the staff and the administrative procedures of this Society. Acting upon the instructions of Council, already quoted, I have given a great deal of attention and study to both since I took office last December. I think we have a splendid staff and that they are doing a top-notch job! I shall not contend that they do not make a mistake on occasion. Who doesn't? And who ever accomplished anything without making an occasional error? But, in my judgment, they are an earnest, intelligent, and highly competent group of professional workers in a field with which I am reasonably familiar. By any standard of comparison, they are distinctly above the average.

I have made it my business to delve rather deeply into some of the business procedures of the Society and, in order to provide a suitable gage, to match them, statistically and otherwise, with comparable activities in other organizations, both professional and commercial. Again, I have found the comparison creditable to the members of our staff and to the procedures which they have set up.

This is not to say that there is not room for improvement here or there; but it is significant that where this is the case, the remedy is often in the works. At every turn, I have found a sense of responsiveness to the wishes of the membership and an earnest desire to listen to criticism and suggestion. I know that our staff executives will welcome yours, whether made directly to them where it is possible, or through the Secretary, or the Executive Committee.

Working for a committee, or a large group of people, as one must do to a considerable extent in a professional society, is not the easiest job in the world, for it is seldom possible to please everybody. But individual morale and an esprit de corps within the organization are prerequisite to successful co-operative activity. I suggest that the effectiveness of our staff will be more or less directly proportional to the extent to which we back up their efforts and make them feel that they have our faith and our confidence. That, then, is the approach to our common problems which I seek from you, not for myself, but for the members of our staff, for I feel that they merit it.

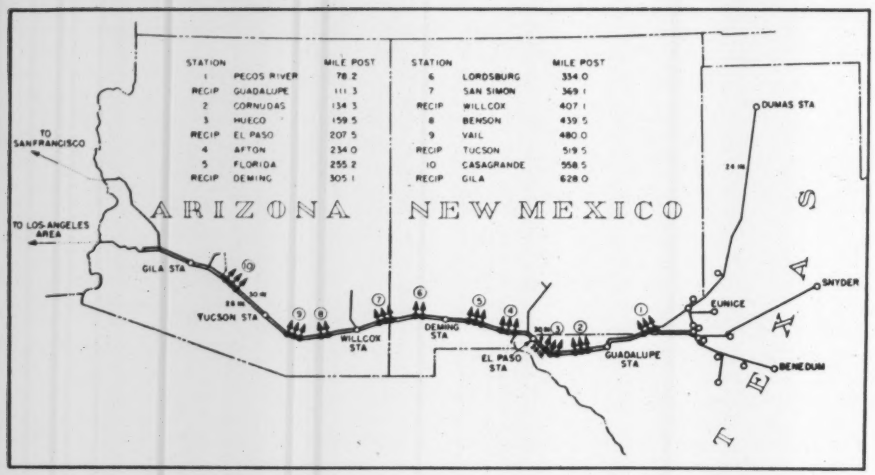


FIG. 1 MAP OF EL PASO SYSTEM SHOWING RECIPROCATING STATIONS AND GAS-TURBINE BOOSTERS

Gas TURBINES *and* CENTRIFUGAL COMPRESSORS

As Applied to Natural-Gas Pipe-Line Service

By T. R. RHEA and J. S. QUILL

CHEMICAL AND PETROLEUM SECTION, INDUSTRIAL ENGINEERING DEPARTMENT, GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

INTRODUCTION

THE General Electric gas turbine for gas pipe-line pumping is being direct-connected to single-stage centrifugal compressors for moving natural gas in major gas trunk lines. Fig. 1 illustrates how these machines are applied. This illustration is of the 28 gas turbines currently being applied to the El Paso Natural Gas system. In this illustration the gas-turbine stations are located approximately 25 miles apart between existing reciprocating stations and are being installed to increase the flow from 700 to approximately 1100 million standard cubic feet per day (MMSCFD). As noted in Fig. 1, there will be stations with two units and stations with three units each. Each unit is of 5000 hp.

Single, two and three-turbine stations are currently being built for other pipe lines. As noted in Fig. 1, turbine-driven centrifugal compressors are placed in series, flowwise, in a particular station while gas-engine-driven reciprocating compressors usually are placed in parallel, flowwise, in a particular station.

Gas-turbine-driven centrifugal compressors are essentially simple rotating machines and are complete self-sustaining power plants in themselves, taking fuel directly from the pipe line and requiring little or no water and no outside electric power. Most of the functions and protective features of a gas turbine are entirely automatic and, therefore, few operating personnel are required.

At the temperatures and speeds at which these gas turbines are operated, they are suitable for the continuous heavy-duty operation required on important applications such as gas pipe-line pumping when burning natural gas. Their reliability and maintenance in service are proving as good or better than steam turbines when steam turbines are considered with their boilers and numerous auxiliaries. Natural gas is, of course, a perfect fuel for them to burn and no other result was to be expected.

ECONOMICS OF STATION SPACING

Fig. 1 shows the location of the gas-turbine stations between existing reciprocating-engine stations. The gas-turbine stations are located about 25 miles apart. The single-stage high-speed centrifugal compressor is inherently a large volume flow, low-compression-ratio machine and lends itself to such applications.

It should be noted that it is 40 to 50 miles between the gas-turbine station and the next downstream reciprocating station because reciprocating compressors do not lend themselves to very low compression ratios at very satisfactory efficiency. It is also worthy of note in this particular application that intermediate booster stations have been applied on these short station spacings in order to bring the line back up to pressure at approximately 25 miles rather than to space the stations

Contributed by the Gas Turbine Power, Hydraulic, and Petroleum Divisions and presented at the Annual Meeting, New York, N. Y., November 30–December 5, 1952, of The American Society of Mechanical Engineers.

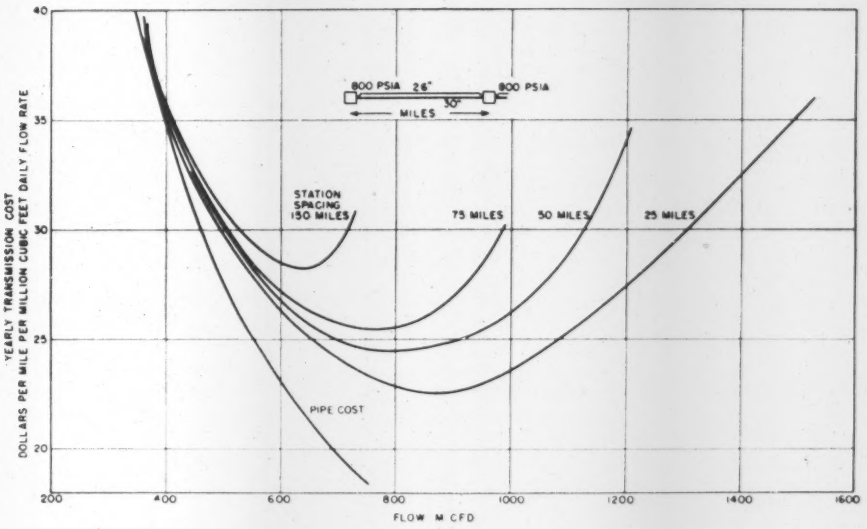


FIG. 2 TRANSMISSION COST VERSUS FLOW FOR SEVERAL STATION SPACINGS

equidistant between the existing stations. This permits the best use of the installed horsepower, keeping in mind that the compression ratios of the reciprocating stations impose a limitation.

Fig. 2 illustrates the economics of the short station spacing for this particular line. No claim to great accuracy is made for Fig. 2 since the cost data on which it was made are out of date in these days of inflation; however, it does show the general pattern. Higher cost data tend to raise the whole set of curves without changing their relative position.

What Fig. 2 does illustrate, of course, is that the transmission cost versus flow goes down with station spacing. It also shows that about the maximum economical limit of flow on a 26-in. and 30-in. line in parallel, operating at a maximum pressure of 800 psia, is around 1100 to 1200 MMSCFD and that beyond this flow, looping should be considered. Thus the El Paso system by the use of gas-turbine-driven centrifugal compressors and short station spacing is squeezing about the maximum out of the system before looping.

The authors do not have accurate knowledge at what point El Paso plans to loop but merely use this illustration to show one of the advantages of short station spacing inherent in the high-volume, low-compression-ratio, gas-turbine-driven centrifugal compressor.

FLEXIBILITY OF ADJUSTABLE-SPEED CENTRIFUGAL COMPRESSORS

The flexibility of adjustable-speed centrifugal compressors in meeting the varying flow and pressure conditions encountered in a pipe line is demonstrated readily by superposing the compressor characteristics and the pipe-line flow pressure characteristics.

Figs. 3 and 4 are the pressure-flow characteristics of two compressors in series in a station. They are based on the calculated performance of the actual designs which are to be applied to Cornudas Station of the El Paso system.

A family of such compressor characteristics is required to illustrate the range of possible performance. Fig. 3 is the characteristic when the discharge pressure is maintained at 813 psia, and Fig. 4 is the characteristic when the discharge pressure is maintained at 750 psia. Characteristics at other discharge pressures could be obtained readily from the compressor manufacturer for these specific compressors but these two will serve to illustrate the point.

The next step is to calculate, from a suitable pipe-line-flow formula (Panhandle in this case) the system pressure maintained at Cornudas for several values of Guadalupe discharge

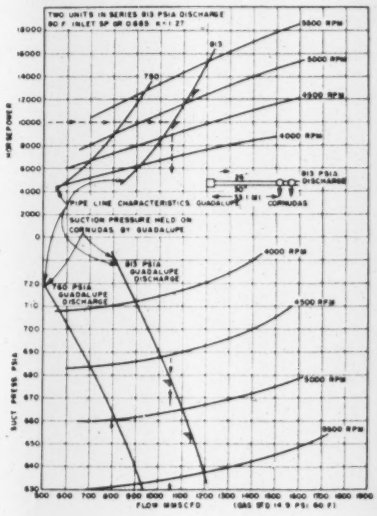


FIG. 3 COMPRESSOR CHARACTERISTICS WITH PIPE-LINE CHARACTERISTICS SUPERPOSED FOR 813-PSIA DISCHARGE

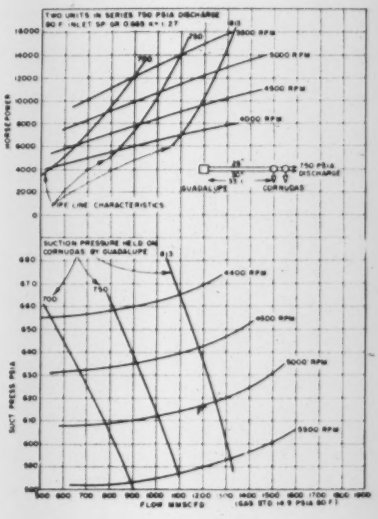


FIG. 4 COMPRESSOR CHARACTERISTICS WITH PIPE-LINE CHARACTERISTICS SUPERPOSED FOR 750-PSIA DISCHARGE

pressure. Pressure-flow characteristics calculated for 813, 750, and 700 psia pressure at Guadalupe are superposed on the compressor characteristics with the results shown in Figs. 3 and 4.

Of these combined characteristics it is possible to ask specific questions about flow and pressure and the ability of the Cornudas centrifugal compressors to maintain flow and pressure.

For example, Cornudas has an available summertime (80 F ambient) output of 10,000 hp. When Guadalupe is maintaining 813 psia discharge, what flow can Cornudas pump back up to 813 psia discharge pressure?

From Fig. 3 the answer of 1050 MMSCFD is obtained by following over the 10,000-hp line until the pipe-line characteristic is reached. Also the information is obtained that the two turbines will run at approximately 4750 rpm each and Cornudas will have a suction pressure of approximately 678 psia. This is the "design point" of the centrifugal compressors, as discussed later.

Suppose, now, that the wintertime (40 F ambient) horsepower of 12,800 is available at Cornudas. How much flow can be pumped up to 813 psia discharge assuming Guadalupe can maintain its discharge pressure of 813 psia?

From Fig. 3 a flow of 1140 MMSCFD is indicated, and the turbines will have to be speeded up to approximately 5200 rpm to maintain this flow.

But now suppose that the upstream station of Guadalupe is only able to maintain 750 psia discharge, what flow could Cornudas pump up to 813 psia discharge?

Reference to Fig. 3 shows that the two turbines delivering their maximum 12,800 hp could deliver 930 MMSCFD at 813 psia. They would be required to run at their maximum speed of 5500 rpm.

Suppose the station downstream from Cornudas demands more flow than this and begins to pull down the discharge pressure at Cornudas to, say, 750 psia. What amount of flow could Cornudas maintain at 750 psia discharge assuming Guadalupe also can deliver at only 750 psia?

Fig. 4 shows that when Cornudas is putting out its maximum wintertime horsepower of 12,800 that it can handle 1070 MMSCFD and maintain a pressure of 750 psia discharge. The turbines would run at approximately 5400 rpm.

Such questions and answers not only demonstrate the flexibility of the adjustable-speed compressors to help pack and unpack the line to the limit of their horsepower ability but they also illustrate the importance of picking the compressor design-point speeds at some lower value than the maximum available of 5500 rpm so that they can be speeded up to obtain the extra horsepower available in cold weather to provide more flow and compression ratio.

SELECTION OF CENTRIFUGAL-COMPRESSOR DESIGN POINT

Fig. 5 shows the flow-compression ratio characteristic to fully load one 5000-hp gas turbine and two 5000-hp gas turbines in series. This characteristic is based on typical single-stage centrifugal compressors pumping natural gas.

A single-stage centrifugal compressor is limited to a compression ratio of about 1.33, and Fig. 5 shows that the minimum flow to fully load the gas turbine of this rating is about 350 MMSCFD. Of course, multistage compressors could be obtained to give higher compression ratios to lower flows and fully load the turbine. Fig. 5 is convenient for quick estimating purposes of the combination of turbine and compressor when applied to a gas pipe line.

The selection of design point is a large subject in itself and it is to be hoped that centrifugal-compressor manufacturers might elaborate on the subject before this Society in a full-length paper.

The design point on the centrifugal compressors is arrived at (after several attempts, usually) by the pipe-line designers and the compressor manufacturers. The basic data on which to make a decision are considered later.

The maximum normal flow of the pipe line is the most important information. In this particular illustration 1050 MMSCFD at 813 psia discharge pressure was selected.

The maximum horsepower available is in this case the 5000-hp summertime 80 F rating and the summer rating was selected in order to be conservative.

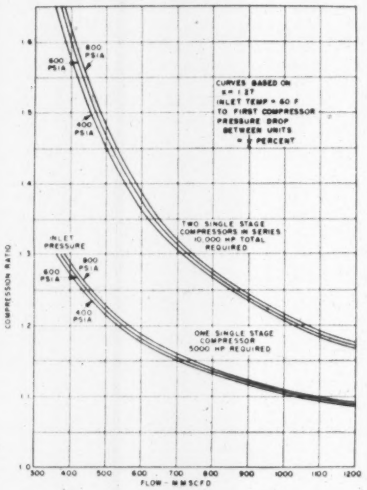

COMPRESSION RATIO
FLOW - MMSCFD
INLET PRESSURE
800 PSIA
400 PSIA
TWO SINGLE STAGE COMPRESSORS IN SERIES 10,000 HP TOTAL REQUIRED
ONE SINGLE STAGE COMPRESSOR 5000 HP REQUIRED

FIG. 5 FLOW-COMPRESSION RATIO RELATIONSHIP TO FULLY LOAD ONE AND TWO 5000-HP TURBINES

With these two limits set, the pressure ratio available is quite well defined. The selection of a design-point speed, in this case 4750 rpm, should give ample margin to speed up the units to their maximum of 5500 rpm and thus absorb the available wintertime horsepower of 6400 at 40 F ambient. This is an important point and illustrates why the flat available horsepower-speed characteristics obtainable from a two-shaft design of gas turbine shown in Fig. 8 are desirable.

The future growth in flow of the pipe line must be considered in selecting the case of the compressor so that a change in wheels and diffusers can be made to accommodate the future expected flow at good efficiency.

DESCRIPTION OF GAS TURBINE

The gas turbine is rated 5000 hp, 5000 rpm at an 80 F ambient and at 1000 ft altitude. It is a two-shaft adjustable-speed machine with a thermal efficiency, when using a regenerator or heat exchanger of 25 per cent based on the lower heating value of the gas.[1] The regenerator is furnished with the unit.

Only the one rating and design is considered applicable to gas-pipe-line pumping in most cases. The authors' company has other designs available but they are considered more suitable to central-station power generation, locomotive power plants, and other applications.

Fig. 6 shows a cutaway view of the gas turbine. The air ducts connecting to the regenerator are not shown. Since the gas turbine does not have the ability to start itself, it is started with gas pressure from the pipe line, expanding to atmosphere through an expansion starting turbine. This gas is not burned.

[1] "Design Features of a 5000-Hp Gas Turbine," by B. O. Buckland and D. C. Berkey, Trans. ASME, vol. 74, 1952, pp. 655–661.

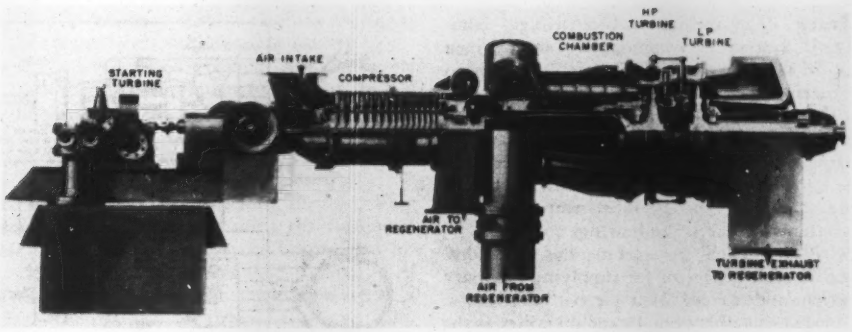


FIG. 6 CUTAWAY VIEW OF 5000-HP GAS TURBINE

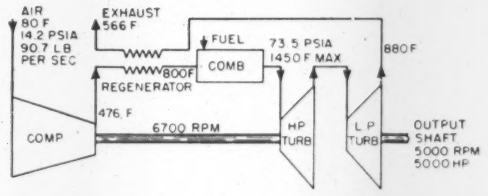


FIG. 7 SCHEMATIC FLOW DIAGRAM OF 5000-HP TURBINE

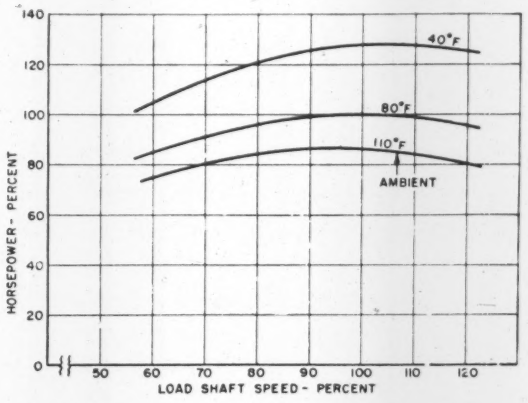


FIG. 8 MAXIMUM AVAILABLE HORSEPOWER VERSUS SPEED FOR SEVERAL AMBIENT TEMPERATURES

The expansion turbine is declutched when the main turbine is able to sustain itself.

Fig. 7 shows the schematic flow diagram of the turbine. It should be noted that the shaft of the load turbine is mechanically separate from the axial-flow compressor and its driving turbine. This separation permits a wide range of speed at almost constant horsepower output.

Fig. 8 illustrates the maximum available horsepower as a function of load-shaft speed for several ambients. These almost flat characteristics are the very desirable features of a two-shaft design for driving centrifugal compressors. For example, a compressor may be picked at its design point, at, say, 4750 rpm to absorb 5000 hp available at 80 F ambient. In cold weather the unit can be speeded up to absorb the maximum available output of approximately 6400 hp at a 40 F ambient. This flexibility is desirable both to the compressor designer and to the application engineer in applying these to pipe lines. Available horsepower of a single-shaft gas turbine falls off very sharply with speed and the machine does not give such flexibility. It is for this reason that two-shaft designs were selected for gas-pipe-line pumping.

Fig. 9 shows one of these gas-pipe-line pumping units on the shipping skid. It is shorn of its starting assembly and lube-oil tank and other external piping but otherwise is shipped as a complete unit.

Adjustable Nozzles. Perhaps one other feature of the gas turbine should be mentioned. Adjustable nozzles are placed between the high-pressure and load (low-pressure) turbine. These adjustable nozzles are controlled automatically from the governing system.[2] Their function is to permit a transfer of the heat energy available between the high and low-pressure turbines. For example, if load were suddenly lost on the load turbine and it should tend to overspeed, the nozzles would be adjusted so that the available heat and pressure energy would

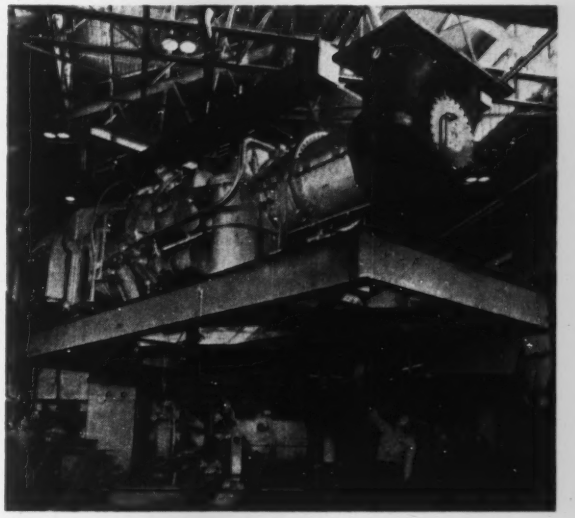


FIG. 9 5000-HP GAS TURBINE ON SHIPPING SKID

be transferred from the load to the high-pressure turbine. Thus the fires would not go out and the load turbine would not overspeed.

These nozzles also are automatically adjusted to give better efficiencies at part load.

[2] "Control of Gas Turbine for Power Generation," by N. E. Starkey, D. C. Hoffman, and A. G. Mellor, AIEE, vol. 69, 1950, pp. 1637-1641.

Lubricating-Oil System. The turbine and centrifugal compressor lubricating-oil system is common. A shaft-driven lube pump supplies oil to both machines. It is important to supply oil to the bearings before the turbine starts and this is accomplished with a d-c motor-driven pump operated from the station storage battery. It is also important to maintain lube oil flowing after a machine has shut down to keep the high temperatures, temporarily existing, from flowing to the bearings and damaging them. The d-c lube pump keeps running 30 min after shutdown to keep the bearings cool.

Auxiliary Electric Power. Each gas turbine has a 125-kw 480-volt three-phase 60-cycle generator for supplying auxiliary power to the station and to its own electric auxiliaries. This power varies in frequency between 45 and 60 cycles as the load on the turbine varies. The auxiliary generator makes the plant completely self-sustaining and it is not necessary to run an auxiliary gas-engine-driven generator in a station when any turbine is running

DESCRIPTION OF STATION

Fig. 10 shows a two-unit station. The air is brought into the turbine through an air washer which can be seen on the outside of the station. This air washer not only cleans the air but also cools it in climates where the humidity is low and thus permits more output from the turbine. The heat exchanger is shown standing on the outside of the station and forms a base for the stack. The operating floor is located about 14 ft above the base of the heat exchanger in order to leave room for the ducts to and from the heat exchanger. The control room shown here between the units, can be located at one end of the building if desired. An inlet-air silencer is connected to the inlet of the gas turbine to insure quiet operation. The heat exchanger acts as a very efficient exhaust silencer. This combination is designed to insure operation that is at least as quiet as conventional steam-turbine power-generating stations. The centrifugal compressor and the connected gas piping usually contribute more noise than the turbine. No fire wall is being installed between the gas turbine and the centrifugal compressor. The building design is such that a fire wall can be inserted.

Fig. 11 shows the plan and elevation of such a two-unit station which is sufficiently accurate for illustrative purposes. A 10,000-hp station requires a building with floor area roughly 48 × 64 ft including a repair and disassembly area.

A 25-ton-capacity crane usually is recommended so that the entire turbine can be lifted as a unit during installation and later if it is necessary.

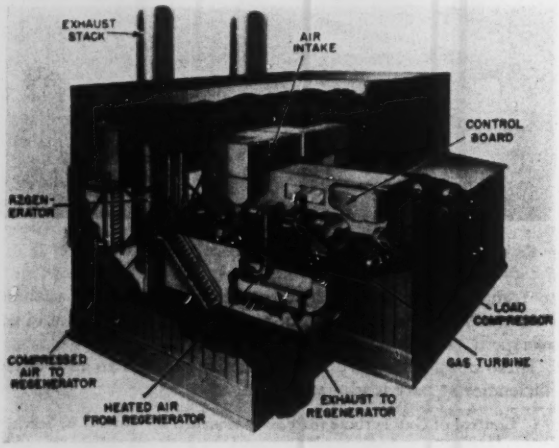


FIG. 10 ARTIST'S VIEW OF TWO-UNIT STATION

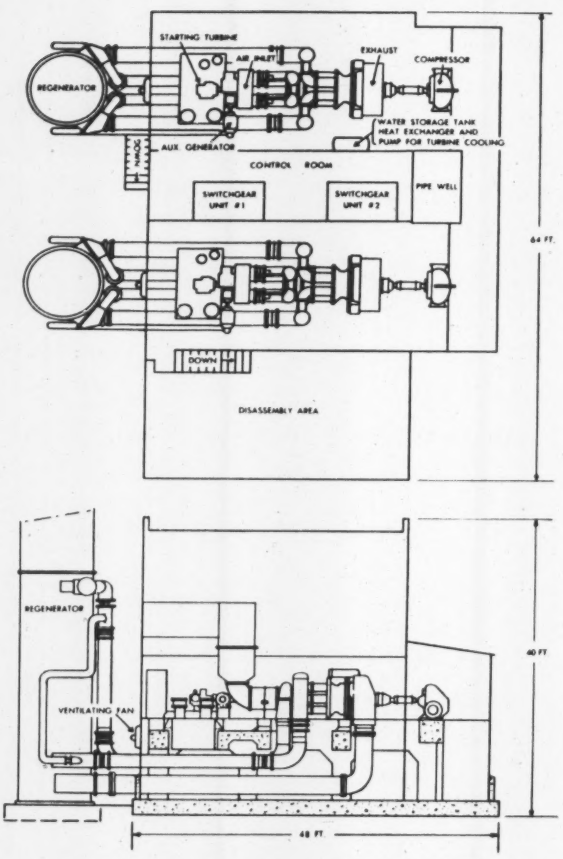


FIG. 11 PLAN AND ELEVATION OF TWO-UNIT STATION

In a station layout there are three important auxiliary pieces of equipment which are not shown in these drawings. One is a gas-engine-driven generator or other independent source of electric power. The turbine does not depend on this engine-driven auxiliary generator but there are times when the turbines will be shut down and lights and other auxiliaries around the station will need to be run. This is the purpose of the engine-driven auxiliary generator. There may be, in some cases, cottages for the personnel which must be supplied with power even though the station is down and engine generator is needed for this purpose. However, as one pipe-line operator puts it, "The gas turbines must be able to start and run and pump gas even though this auxiliary engine is itself torn down and scattered all over the floor."

Station Battery. The station battery is the second important auxiliary. The station battery enables the turbine to start and run even though there is no other source of power. The station battery supplies power for control, ignition, and for pumping lubricating oil during starting and stopping. Without the storage battery the unit would not be able to start or stop without damage to the bearings. Furthermore, it is not wise to depend upon an outside source of power such as a gas-engine generator or purchased power for the lube-oil circulation for starting and stopping because this is not as reliable as a properly maintained battery. This is by no means an

innovation, since most large steam-turbine stations also have an emergency d-c lube pump based on the station battery.

The third auxiliary is a water-to-air fin-type heat exchanger to remove the 20,000 Btu per min from the lubricating oil and turbine-jacket cooling.

Operator's Control Panel. Fig. 12 shows the front of the operator's control panel. An annunciator is provided to tell the operator whenever an automatic device has functioned.

The gas turbine is essentially an automatic device. Very briefly, the control equipment furnished with the turbine is designed to permit the operator to press one button and for the turbine to accelerate, open gas valves, and to load itself and then automatically hold station discharge pressure at a preset level. In fact, the operator can have a forefinger 1000 miles long for pressing the button if remote supervisory control and suitable communication channels are provided. If the machine gets into trouble, such as hot bearings or excessive vibration, or gas pains around the heart, the control is arranged to shut the machine down, yell for help, and then show the doctor where it hurts.

Station Valving. Fig. 13 shows the mimic main gas valving and piping associated with the centrifugal compressor with the valve controls shown.

Note that a 2-in. valve is placed around the big 30-in. suction valve. This small by-pass is used to purge and pressurize the compressor slowly. The switch in the center is for a valve that by-passes the entire station and its function is not shown on the mimic bus.

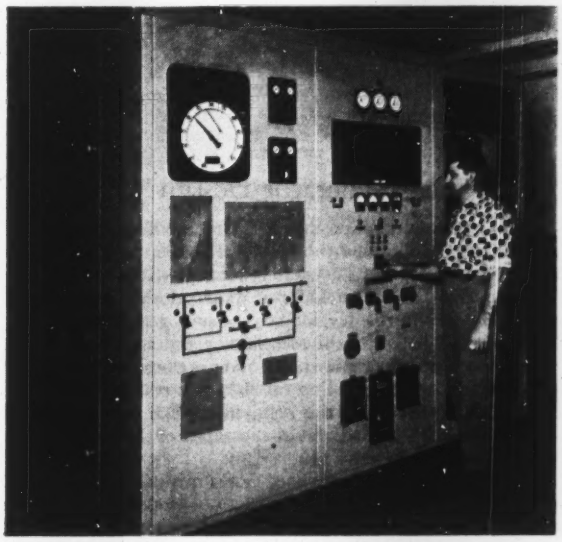


FIG. 12 OPERATOR'S CONTROL PANEL

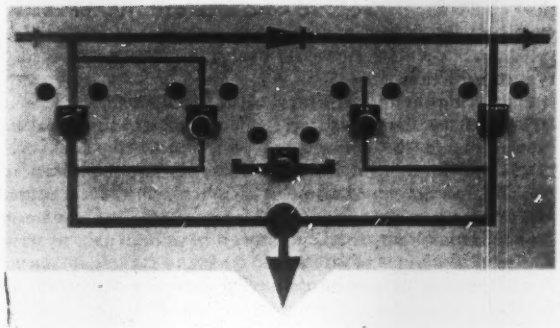


FIG. 13 STATION VALVING SCHEMATIC MIMIC

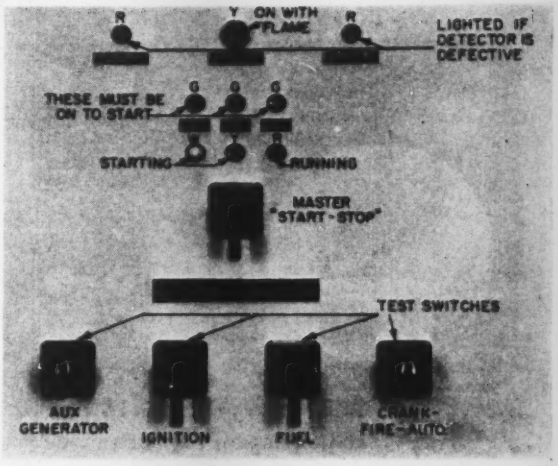


FIG. 14 OPERATOR'S CONTROL SWITCHES

The station valves can be operated manually from this board or the operator can turn them over to automatic operation if he chooses and they will operate in the proper sequence when the turbine is started.

For an automatic sequence of operation consider that initially the suction, discharge, and purge valves are closed and the vent and station by-pass valves are open and that all of the gas turbines are shut down. When the turbine first fires, the purge valve opens. Ten seconds later the vent valve closes and two minutes later the suction and discharge valves open. Thus all of the valves (except the vent valve) are open before the load shaft breaks away from the rest.

When one turbine has come up to its idling speed and when, in the operator's judgment, the pressure across the entire station is sufficiently equalized, the operator will close the main station by-pass valve, using the "by-pass" switch shown in Fig. 13. Subsequent turbines after the first can, of course, be brought up to speed and loaded without disturbing the by-pass valve in its closed position.

Starting. Fig. 14 is an operator's eye-view of the control panel. At the top are lights associated with two separate and independent flame detectors which are used to check the flame in the combustion chambers. The large yellow light located in the center is lit whenever there is flame in the combustion chambers. The smaller lights on either side of the large light are used to indicate trouble with the flame detectors themselves. The system functions on one flame detector with the other as a backup for it.

Immediately below are six signal lights. The top three are green and indicate that the equipment is ready to operate. For example, if one of the breakers in the motor-starter control were open, one of the green lights would be out and the operator would know where to look for the trouble.

To start the turbine the operator must have the three green lights lit. He then places the operation selector switch in the "automatic" position and twists the "master" start switch manually to the start position. When he does this the green "ready" lights go out and the white light comes on indicating that the d-c lube pumps have filled the overhead compressor-seal oil tank, the white light goes out, and the yellow light comes on and stays on until the starting sequence is complete.

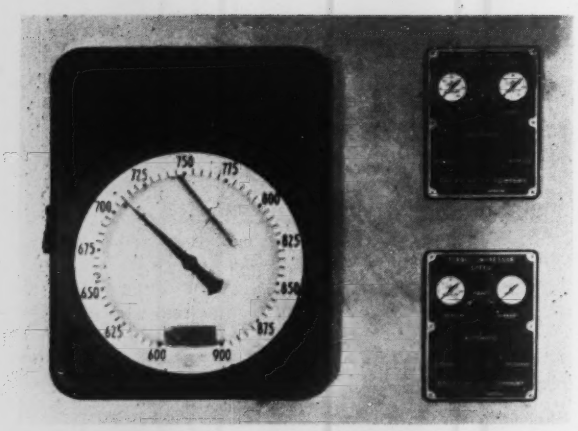


FIG. 15 STATION PRESSURE CONTROLLER

During the time that the yellow light is on, the starting turbine brings the gas turbine up to 10 per cent speed for a 5-min purging interval. The turbine is then fired and comes up to 60 per cent (idling) speed by means of the power it can develop itself with the assistance of the starting turbine. Somewhere around 50 per cent speed the gas turbine runs away from the starting turbine and the starting turbine shuts down.

At 60 per cent speed the starting sequence is complete and the red light comes on. The entire starting requires about 20 minutes.

The other switches in Fig. 14 are for testing various phases of the operation and are not used for normal starting.

Operation. The operator has a choice of two modes of operation. He can control the speed of the turbines manually or he can turn them over to the automatic discharge-pressure control.

The Bailey pressure recorder and controller for the turbine are shown in detail in Fig. 15. For pressure control, the operator places the selector valve in the automatic position. The regulator then feels of the station discharge pressure and controls the turbine fuel (and speed) to maintain this pressure. Temperature and speed-limit overriding controls prevent the turbine from damaging itself.

When the operator wishes to control the speed of the turbine manually, he places the selector switch, Fig. 15, in the "manual" position and adjusts the speed by means of the knob below.

Stopping. When the stopping signal is given to any turbine, whether by the operator or by any of the automatic shutdown devices, a pressure ratio exists across the entire station, and a station check valve will prevent the gas from flowing backward. When one of the several turbines in a station is thus shut down, the remaining ones may not be able to develop sufficient pressure ratio to span the station compression ratio immediately. Therefore it is important that the station by-pass valve be opened automatically on such signal to give a path for the gas to flow through the units without surging. If this were not done the station check valve would cut off the flow until the station compression ratio equalized, which might leave the compressors in surge for 15 or 20 min.

The remaining turbines in the station continue to run but are brought to idling speed automatically. When the station pressure ratio has equalized sufficiently so that the remaining turbines can span it, the station by-pass can be closed and the remaining units put back to work pumping gas.

The stopping signal shuts off fuel to the turbine and it starts to coast to rest. At 40 per cent speed, the d-c lube pump starts, and the unit is at rest in approximately 7 min. The d-c pumps run 30 min in order to keep the bearings cool during the transient flow of heat from the hot turbine parts.

SUMMARY

The reasons why gas-turbine-driven centrifugal compressors for main gas-pipe-line pumping are becoming popular can be summarized as follows:

1 Low maintenance and operating cost. A total of 5 men per station is visualized for one, two, or three-unit stations.

2 Short station spacing made possible by centrifugal compressors and automatic or semiautomatic nature of gas turbines results in additional capacity of pipe lines.

3 Gas turbines develop 25 per cent extra horsepower in the wintertime at no increase in installed cost.

4 No water required. Machine will run without air washer.

5 Low oil consumption. Estimated 12 gal per month per 5000-hp unit, including compressors. Little, if any, of this oil is passed into the pipe line which is an important advantage from a point of view of clogging the pipe.

6 Flexibility. The adjustable-speed drive permits operation over wide range of flow conditions.

7 Self-sustaining, no outside electric power required for operation of the turbine.

8 No pulsations transmitted to the pipe.

9 Provision for future increased flow can be made by applying oversized compressor cases and then changing wheels and diffusers when the flow increases.

Generator Design

AN analytical technique developed by the Engineer Research and Development Laboratories, Fort Belvoir, Va., for calculating the design of 400-cycle generators without recourse to test data from actual machines of similar design has played an important part in the development of such generators.

Simple and accurate, the technique permits an exact evaluation of both transient and steady-state performance to be made on paper without depending on elaborate test data. Lack of industrial experience in the required type of generators made such information unavailable at the outset of the generator program at ERDL four years ago.

ERDL development was aimed at a family of lightweight 400-cycle generators from 0.15 kw to 100 kw at 0.80 power factor, having long life, excellent wave form and transient response, and capable of mass production. Some work had been industrially on slower-speed 400-cycle generators. Their performance, however, did not meet military requirements, and they could not be produced on a large scale by the average manufacturer. Most industrial experience was limited to high-speed aircraft units designed for short life and requiring special-type construction.

Employing the analytical approach, ERDL engineers, despite lack of comparative data, were able to predict substantial improvements in the performance of the slow-speed 400-cycle generators through the incorporation of certain modifications.

ERDL has developed a line of satisfactory 400-cycle engine-generators up to and including 60 kw at the 0.80 power factor. By similar methods, the Laboratories have been able to arrive at electrical designs of 30-kw and 60-kw, 400-cycle, 1714-rpm, permanent-magnet generators having exceptionally good electrical characteristics and weighing 302 and 575 lb, respectively.

Work is progressing on 12,000-rpm and 24,000-rpm 100-kw 400-cycle generators.

MECHANICAL APPLICATIONS *of* FLOWED-IN GASKETS

By W. M. RAND, JR.

DEWEY AND ALMY CHEMICAL COMPANY, CAMBRIDGE, MASS.

INTRODUCTION

FEW engineers realize that approximately 2000 separate items would be required to renew every gasket in an automobile. Nor is it common knowledge that each end of a tin can contains a thin rubber gasket in the seam to protect the contents. Recent developments, however, have indicated the possibility of sizable economies in this phase of machinery design and construction, and cost-conscious engineers are becoming more interested in the subject.

Generally, a gasket is cut or molded to the desired shape from material appropriate to the sealing requirements. In today's general practice this gasket is then positioned manually or glued to the part before assembly of the unit. Production speeds are low, labor and scrap-material costs are high. Now a new method—the flowed-in gasket principle—offers the same sealing efficiency with substantial savings in labor and materials and increased production speeds.

The flowed-in principle is simple; a liquid synthetic-resin or rubber compound is flowed into the gasket channel. The entire part, with gasket applied, is then baked and the compound becomes a solid rubbery gasket. Circular gaskets may be applied, using automatic machinery eliminating many hand operations; irregularly shaped gaskets also may be flowed-in using conventional hand spray-gun equipment. Although the idea of flowed-in gaskets is not new, its application to industrial gasketing problems only recently has received the close attention of the engineer.

Consider the case of a manufacturer of pressure and vacuum gages, fuel-level gages, and other instruments with glass faces. When the glass face and outer retainer ring were crimped or rolled onto the instrument body during final assembly, glass breakage was high; cut gaskets, when used, would fall out of position; there were three separate parts to handle. When flowed-in gasketing was used, the flowed-in compound not only caused the glass and ring to adhere as an integral part, but permitted positive sealing and substantial reduction of breakage because the flowed-in gasket was positioned properly in each face assembly.

In another industrial application, an expensive neoprene gasket manually applied to an automobile air cleaner was replaced by an equally resistant compound flowed-in by machine. Economies in labor alone were sufficient to justify the change-over.

While there are many advantages, quite naturally, flowed-in gaskets also have their limitations. They are not resistant to the same high temperatures as are asbestos materials. Nor is it feasible to apply gaskets of much less than $^3/_4$ in. diam. Frequently, the high quality of a rubber gasket is not practical economically. In general, however, the low cost of the flowed-in materials, the laborsavings through machine applications, the good adhesion and sealing properties these gaskets provide make them important in many industrial applications.

Contributed by the Rubber and Plastics Division and presented at the Annual Meeting, New York, N. Y., November 30-December 5, 1952, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

What are the requirements, then, of a flowed-in compound? What materials meet these requirements? How are the compounds applied and how are they baked to form the gasket?

FLOWED-IN GASKET MATERIALS

Materials for low-pressure nozzle application as gaskets must meet three general requirements as follows:

1 They must be stable liquids with low viscosity and relatively high thixotropy; i.e., they flow only after a certain minimum force is applied.

2 They must be convertible to solid or sponge films of desired thickness by simple and controllable means in a short time.

3 As films, the gaskets must have a wide range of resistance to the effects of temperature, pressure, liquids, and gases for the required period of time.

Liquid materials that fill these requirements are as follows:

1 Vinyl plastisols and organisols.

2 High-solids-solvent solutions of the various oil-resistant synthetic rubbers.

3 High solids-water dispersions of natural or synthetic rubber.

The plastisol and organisol compounds are especially adaptable as industrial flowed-in compounds because a wide range of viscosity is possible. The low-viscosity materials (1000 cps) will reflow under heat just prior to gelation giving smooth, level gaskets. High-viscosity compounds (up to 50,000 cps) can be made to stay put as applied where other compounds might run or slump, and short baking times are possible.

The characteristics of plastisol gaskets are generally known. Moisture transmission through the film is very low; resistance to aqueous liquids, many oils, atmospheric conditions, pressure, and vacuum is good. The film is tough, semielastic, and pliable. Low degree of solvent resistance can be improved by overpainting with solvent-resistant paints. Solid or cellular gaskets are possible.

The moisture-resistance properties made these compounds especially adaptable as gasket material for aluminum container covers for 35-mm photographic film. The covers pass from the forming and degreasing equipment through an automatic compound-application machine and short-conduction oven at a rate of 80 per min. The caps are then ready for painting and final application to the containers.

Four major improvements over the use of precut gaskets have resulted:

1 Gaskets do not fall out during hopper handling of caps.

2 Eccentric gasket application and consequent leakage are eliminated.

3 Improved moisture-transfer resistance.

4 Increased production speed.

The second group of flowed-in materials, high-solids-solvent solutions of such polymers as neoprene, Buna N, and Thiokol

are especially effective where a high degree of solvent resistance is required.

The film ordinarily is formed by a dual drying-baking operation. The drying phase drives off the solvent and generally requires 1 1/2 hr. The baking cycle of approximately 1 hr at 325 F cures the film for the added solvent resistance necessary. This relatively slow-speed drying-baking cycle necessitates baking the gasketed parts on trays for full efficiency. Some of these compounds may be baked in as little as 30 min. The excellent adhesion of these materials to most metal surfaces makes them especially adaptable where considerable handling of the gasketed part is involved. Low to medium-viscosity compounds make varied positioning of the gasket possible.

One interesting application of this type of material is in the manufacture of automotive shock absorbers. Circular welding of the 1 1/2-in-diam cap for a shock-absorber cylinder, an operation very difficult to control, has been eliminated. This cap is now lined with an annular gasket of solvent neoprene compound near its circumference; caps with compound applied are baked for 60 min at 325 F in a gas-fired oven. The finished part is then crimped to the cylinder in a simple rolling operation in which the top edge of the cylinder is forced over onto the gasket to form the seal. Production has been increased, but the greatest advantage in this new application has been the substantial reduction of leaky cylinders.

Another group of flowed-in compounds is listed as high solids-water dispersions of natural or synthetic latices. Starting from neoprene, GRS, or natural-rubber latex with a solids content in the range of 30 per cent to 65 per cent, compounds may be formulated up to 85 per cent total solids. Once again, high total solids make possible short drying times and thick gaskets when the films are dried. As liquid compounds, these materials have good storage stability since activators, if required, may be added where necessary just prior to use.

Drying of these water-base compounds to solid or sponge films requires from 10 min to 2 hr. Gas-fired ovens with recirculating-air temperatures of about 200 F or less have proved most satisfactory. The resulting film is softer than the two types previously considered and, like the others, may be designed with a slight wax surface bloom. It has good moisture-vapor resistance and is specifically applicable where a gasket for protection against vibration or shock is required.

TABLE 1 CHARACTERISTICS OF FLOWED-IN SEALING COMPOUNDS

	Plastisols	Solvent compounds	Water dispersions
Total solids, per cent	100	50–90	70–85
Viscosity, cps	500–40000	1000–500000	1000–100000
Specific gravity of solid film	1.3–2.0	1.5–2.0	1.2–2.0
Application temperature, deg F	110–120	Room temperature	Room temperature
Application method	Hydraulic pressure	Hydraulic pressure	Air pressure
Unsupported film thickness (max), in	0.075	0.050	0.100
Average baking schedule	1 min/350 F	120 min/325 F	90 min/210 F
Adhesion to untreated metal	Fair	Good	Good
Oil and solvent resistance	Fair-poor	Good	Fair
Effective temperature range, deg F	0 to 200	−45 to 300	−45 to 250

Table 1 reviews the principal characteristics of the three groups of compounds discussed.

FLOWED-IN GASKET APPLICATION

With an intimate knowledge of turbulent and laminar flow and of viscosity, dilatancy, and thixotropy, the colloidal chemist can adjust the compounds discussed here so that they may be controlled accurately in their flow properties. But the engineer is equally important in the application of flowed-in gaskets since the mechanics of the nozzle and its controlling mechanism determine the accuracy of both film weight and gasket placement. Where tolerances of weight and position

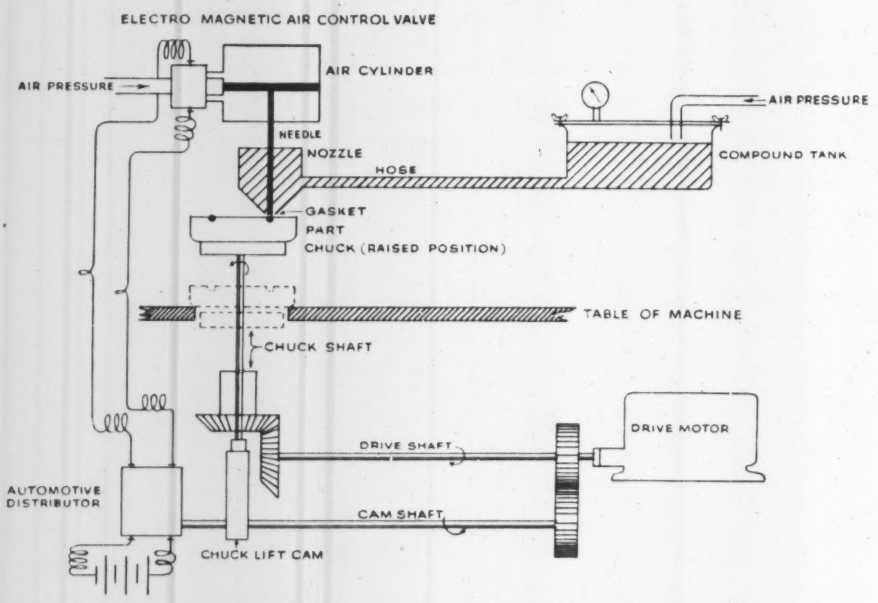


FIG. 1 SCHEMATIC DIAGRAM OF FLOWED-IN GASKET-APPLICATION MACHINE

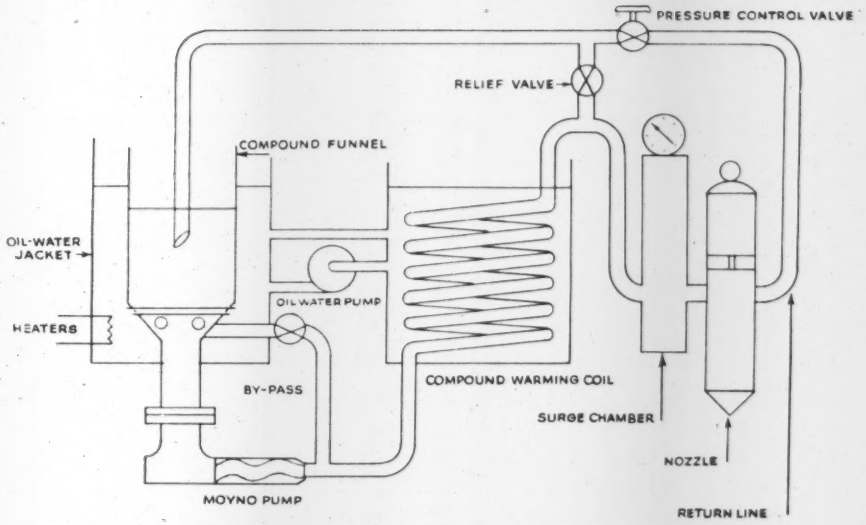


FIG. 2 SCHEMATIC DIAGRAM OF CONTROLLED-TEMPERATURE COMPOUND-PUMPING UNIT

of the gasket are not stringent and production rates slow, hand appliances may be used such as paint sprayers or grease guns. The liquid gasket is squirted into place as desired and the gasketed part then placed in a suitable oven for baking of the compound to a rubbery film. The area requiring a gasket may even be dipped in the compound and then baked. Where a circular gasket and higher production speeds are called for, however, semiautomatic or automatic equipment is required. Such equipment has been in use for many years in the can-manufacturing and metal-screw-cap industries for application of sealing compounds to metal caps for glass jars and to the ends of tin cans prior to can assembly.

The principle of machine application is simple. The part to be lined is placed manually or automatically on a table over a spinning chuck; the chuck rises through a hole in the table carrying the spinning part up under the tip of a mechanically, pneumatically, or electropneumatically controlled nozzle. The nozzle, being timed with the spinning of the part, is then opened so that a controlled amount of compound flows into place. A circular deposit results since the nozzle is stationary and the part is spinning beneath it on a concentric shaft. When the lining is complete (after 1, 2, or 3 revolutions), the chuck of the lining machine then drops to its initial position below the table level and the lined part may be removed by hand or by a take-off device automatically in time with the rise and fall of the chuck.

Fig. 1 describes schematically the essentials of the application. As is seen from the diagram, four principal mechanisms are involved:

1 The nozzle and its control.
2 The chuck-drive and chuck-lift mechanism.
3 The compound-supply system.
4 The mechanism for supplying and removing parts automatically (not shown).

Nozzle Mechanisms. There are many possible variations to nozzle-mechanism design. For instance, a direct mechanical linkage for opening and closing the nozzle is possible, operating directly from a cam on the camshaft. Can-end lining-machine nozzles operate in this fashion at speeds in excess of 300 units per min. If linkage is kept to a minimum, this system works very well. Excessive linkage generally results in lost motion and loss of control. Accurate 1 or 2-revolution linings are thus difficult; and film weights, hence gasket dimensions, will vary.

An air plunger actuating a simple needle-lifting lever may be used for opening the nozzle. This air plunger, in turn, is operated by an air control valve driven directly off a lining cam on the camshaft. This system works well where high lining speeds are not required. It is apparent, however, that there will be an undesirable air-cushion effect if the air line from the air-control valve to the nozzle-opening plunger is long.

Perhaps the best mechanism for nozzle control is the one shown in the diagram. A standard adjustable automobile distributor is driven by the camshaft of the machine. Electrical impulses from the distributor are relayed to an electromagnetic air valve which directs high-pressure air above or below a small piston. The piston rod is connected directly to the nozzle needle so that very fast and positive opening and closing of the nozzle are possible. An electropneumatic nozzle such as this may operate at 600 strokes per min. On machines operating commercially at speeds of 150 parts per min, film-weight control with this nozzle has been maintained within 5 per cent.

It has been found necessary to use direct current for the best operation of this nozzle mechanism at speeds above 50 per minute in order to avoid the slight lag encountered when the distributor makes contact at the same moment the alternating-current charge may be changing sign.

Chuck-Drive and Chuck-Lift Mechanisms. Though the main-drive and chuck-lift mechanism may be primarily a simple gear system, it is worth noting that good control of the rotational speed of the chuck is desirable since the chuck speed, in turn, controls the centrifugal force exerted on the deposited compound once it has been applied. Chuck speeds for the compounds discussed may range anywhere from 200 to 2000 rpm. When a simple flat gasket is desired, for example, a low chuck speed will apply, since, as was described earlier, the best flat gasket will be laid down from a low-viscosity compound. A low chuck speed will not throw a low-viscosity compound off the spinning part. Refinements to the machine are possible where necessary, such as magnetic inserts in the chuck for better traction on light steel parts or chucks and chuck shafts modified for use with plastic, aluminum, paper, or wooden parts by use of a hollow shaft attached to a small vacuum pump.

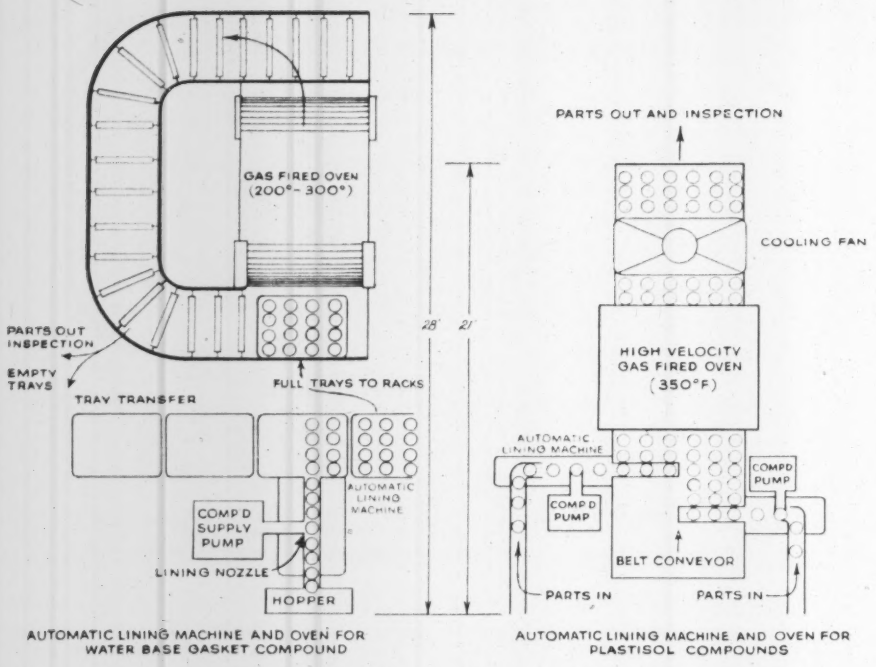


FIG. 3 TWO TYPICAL FLOWED-IN COMPOUND-APPLICATION UNITS

Compound-Supply System. A system for supply of compound to the nozzle may be quite simple as shown in Fig. 2. Air pressure forces the compound to a dead-end nozzle. Where close control of temperature is required for control of viscosity, or where high pressures are necessary to move high-viscosity materials, other methods of supply are more practical. A controlled-temperature recirculating pumping unit is generally used for the plastisol compounds previously discussed. The compound is heated in a reservoir and recirculated by pump. The warm compound passes through the tip of the nozzle at a flow rate of roughly 5 times that required for lining. This flow-through principle keeps the nozzle tip warm without auxiliary heating equipment and also prevents a large pressure drop when the nozzle opens.

Since all colloidal fluids suitable for flowed-in gaskets vary in viscosity with temperature, and since viscosity determines the flow rate through a nozzle at a given pressure, it is desirable to control the temperature of application. Temperature control within 2 deg F is possible and pressures ranging from 20 to 90 psi may be developed.

One additional method of supplying compound to the nozzle is the conventional air-motor positive-displacement pump such as is used for pressure-lubrication of automobiles. With a low-pressure air supply, a high-pressure compound supply is possible. This piston-type pump is best used in supplying material to a dead-end system as initially described, since a relatively large supply of air otherwise would be required. For dead-end supply of high-viscosity solvent neoprene which otherwise would be unlinable, this pump has proved very useful.

Supplying and Removing Parts. Since there are as many devices for supplying parts to the chuck and then removing them as there are different parts being lined, no further description is necessary than to say that dial feed, reciprocating slide bars, air jets, conveyers of all types, and star wheels mounted in any number of ways to the base or table of the machine are in use today and mention of them should serve to start the mechanical imagination working. One important feature of an automatic machine must not be overlooked, however. It will be apparent that a timing device will be necessary to prevent flowing of compound from the nozzle should there be an interruption in the supply of the parts to the chuck. This may be accomplished by placing a small detector microswitch in the feed mechanism to break the electrical system to the nozzle-operating distributor when steady feed of parts is interrupted.

In the case of the other types of nozzle mechanisms, electric solenoids may be actuated by an interruption of parts supply, and the solenoid, in turn, may be utilized to interrupt the nozzle linkage, preventing opening of the nozzle.

BAKING THE APPLIED GASKET

Once applied, compounds may be baked or dried in any number of ways. In the case of the third group of compounds, the water dispersions, a simple drying takes place, so that an oven with recirculating air heated by gas or electricity, will meet the requirements. Since the drying may take up to 90 min, it becomes necessary to place the parts on trays or in stacks and to pass the trays or stacks through the oven in racks. Recently some water-based dispersion compounds have been developed that will dry in 10 min; and for these, ovens have been built to permit dropping of the lined parts directly from the liner onto the conveyer of the oven in which they are baked, thus eliminating the labor necessary in tray stacking. Fig. 3 shows typical compound-application units.

CONCLUSION

Gaskets are widely used in all phases and types of manufacturing and their handling in assembly has posed many problems. Any method by which this handling is simplified and mechanized certainly should be welcome to the engineer in his constant search for ways and means to cut production costs.

Work in Great Britain on Corrosion and Deposits in Air Preheaters

By A. A. BERK

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THIS paper reports information obtained in England from G. Whittingham, Superintendent of Combustion Department, British Coal Utilization Research Association; H. E. Crossley, Scientific Adviser, British Electrical Authority; and A. Parker, Director of Fuel Research, Department of Scientific and Industrial Research. These three groups constitute the principal working organization for the Boiler Availability Committee.

A bibliography of the more recent papers on fouling and corrosion will be released during the next 6 months by the Boiler Availability Committee. Two bulletins will contain abstracts of 101 papers published during 1940–1951. Forty-two of the papers report projects of the Boiler Availability Committee.

LABORATORY FINDINGS

According to Dr. Whittingham, the principal laboratory findings are as follows: A mechanism for sulphur-trioxide formation, several methods for its removal from the flue gases, several methods for its determination, and several methods for predicting whether the SO_3 content of the gases is dangerously high. Other laboratory work has led to classification of coals on the basis of volatile inorganic mineral content.

Briefly, sulphur trioxide is said to be produced during the combustion of carbon monoxide. It may be formed in the furnace, or at the superheater if there is delayed combustion of the carbon monoxide. Water vapor interferes with SO_3 formation, so that more SO_3 will be formed during burning of the coke than during burning of the volatiles. Despite its thermodynamic instability at high temperatures, SO_3 will not revert to SO_2 in the furnace unless enough surface is provided, because the reaction occurs only at a solid interface.

The dusts used in the laboratory for reverting SO_3 to SO_2 include carbon, zinc oxide, silica, and fly-ash produced by auxiliary pulverized-fuel-firing. The effect of carbon smokes in reducing sulphur trioxide is attributed mainly to direct chemical reduction. Zinc oxide forms a sulphate with sulphur trioxide below 1100 F. Alkaline pulverized-fuel ash was found to react with sulphur trioxide but not with the dioxide. The laboratory data indicate that some dusts do not remove the SO_3 materially but instead provide the necessary surface at which reduction or thermal decomposition takes place. Special chemical methods of flue-gas analysis for the sulphur oxides were developed for this work.

This viewpoint essentially ignores the ferric sulphate (Rylands and Jenkinson) and iron oxide (Harlow) catalysis theories. It is recognized that many catalysts may affect the sulphur-trioxide concentration in the flue gases and that the iron compounds may contribute to increase the sulphur-trioxide content. However, this catalytic effect is considered to give rise to relatively little of the trioxide.

Dr. Crossley and his associates analyzed many samples of the coals which have given trouble in some installations but not in others, and they arrived at a correlation based on sulphur, alkali chloride, and phosphorus. Essentially, this classification predicts that high sulphur will cause air-preheater trouble; a combination of high sulphur and high chloride will move the trouble to the superheater. Also, as little as 0.04 per cent phosphorus will produce phosphate deposits if the coal is burned in a deep fuel bed and temperatures higher than 2900 F are reached.

DEW-POINT METER AND PROBE—APPLICATIONS

The outstanding recent laboratory achievement has been the very good correlation between special dew-point measurements and corrosion probe findings. This stems from recognition that it is not the dew point but instead the rate of acid build-up which is the principal factor in corrosion and deposition troubles. The principle of the meter is the conductivity measurement at a surface held by compressed air cooling to a known temperature which is measured by a thermocouple. The rate of acid build-up is estimated from the rate of increase of conductivity, as determined with a stop watch, at any particular temperature below the dew point. The acid then can be volatilized by raising the temperature of the surface, and the instrument is ready for further testing. Unfortunately, alkali sulphates and fly-ash also deposit, and frequent cleaning of the surface is necessary. Therefore there is no possibility that the present instrument can be used with a recorder or as a controlling device.

The most serious acid build-up occurs 40–80 F below the dew point, and the corrosion probe corroborates this temperature range to be most troublesome for corrosion and deposits. The probe exposes a hemispherical test surface of mild steel, which is cooled as desired with compressed air and the temperature measured with an embedded thermocouple.

Both the dew-point meter[1] and the probe[2] are discussed and described elsewhere in some detail. The dew-point meter is available in two boxes.[3]

In general, application of the dew-point meter and probe testing units in power plants has correlated well with the incidence of corrosion and deposits. There have been exceptions, however, and the most notable has occurred at Preston. With a 3.5 per cent S coal, the Preston operator was having serious trouble, and the meter showed high dew point to be the cause. The operator experimented and made many changes over a short period, so that the relative significance and effect of the individual changes cannot be evaluated. However, at least one of his improvements worked, because the trouble suddenly disappeared. Nevertheless, the dew-point meter and probe show that his flue gases should give him at least as much trouble as he had before the changes were made.

Contributed by the Research Committee on Low-Temperature Flue-Gas Corrosion and Deposits of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[1] "Developments in the B.C.U.R.A. Dew-Point Meter," by P. F. Corbett, D. Flint, and R. F. Littlejohn, *Journal of the Institute of Fuel*, vol. 25, November, 1952, pp. 246–252.

[2] "An Air-Cooled Metal Probe," by G. G. Thurlow, *Journal of the Institute of Fuel*, vol. 25, November, 1952, pp. 252–255, 260.

[3] Victoria Instruments, Midland Terrace, Victoria Road, London, N.W. 10, England.

Attempts were made to make similar changes in other plants, but results were very poor. The most recent plan in the investigations at Preston proposes to raise the superheater-metal temperature by supplying less steam to the superheater; if corrosion returns to the air heater in consequence of this change, the iron-oxide-catalysis theory may assume greater importance. A further plan is to run one boiler on coals of high sulphur but low alkali-chloride content, in a different approach to find the critical factor. Because of results at Preston, the dew-point meter is regarded in England as a good laboratory instrument for use with clean gases but of doubtful value for field testing.

APPLICATION OF DUSTING METHODS—CLASSIFICATION OF COALS

There are only two stations at which dusting methods are used, Brimsdown and Battersea. Both introduce the dust as auxiliary pulverized-fuel firing. Furnaces in England are mostly of the shoe-box type and are not large enough for useful dusting or fly-ash recirculation. Besides, operators don't like the idea of returning ash to the furnace and authorities don't like the thought of the extra dust pollution from the stacks.

Of the two stations using auxiliary pulverizer fuel, Battersea employed it principally to avert phosphate deposits. One reason that it has been successful, but not necessarily the main reason, is the decreased depth of the fuel bed, since part of coal is burned above the grate. Crossley's curves show that the bed temperature was reduced to below the phosphorus volatility point. However, Dr. Parker pointed out that the significant results at Battersea were obtained only after flue gas was recycled in the primary air to the furnace to lower the grate temperatures and raise the temperature at the cold end of the air preheater. With auxiliary pulverizer fuel, boiler availability was raised from 500 to 1500 hr; with recycling of 10 per cent of the flue gas, availability was increased to 4000 hr.

The record for the Loeffler boilers at Brimsdown is similar. Here special dampers were installed so that some of the hot flue gases could be used to heat the incoming air; moreover, the air preheater was converted from countercurrent to parallel flow. These changes, plus the use of auxiliary pulverizer fuel, have increased boiler availability significantly. The operating men believe that the sacrifice of efficiency did more good than the pulverizer fuel.

The most significant achievement based on providing better coal to sensitive stations has been in Britain's only wet-bottom pulverized-fuel plant. Crossley's theory predicted that coal which had been satisfactory in dry-bottom furnaces might cause trouble because slagging would boost the ratio of alkali to dust. The troubles did come very quickly, and relief was obtained when a coal of lower chloride content was substituted. Crossley's theory would predict even more critical selection to be necessary with cyclone firing. Similar, though less spectacular, results have been obtained at other stations, where selected coals are fired with the object of obtaining good availability at base-load stations.

IMMUNITY PERIOD IN NEW BOILERS

The consensus is that there is no such immunity period. On the other hand, the importance of starting with clean surfaces is recognized, and the proudest achievement of the Boiler Availability Committee is that it has convinced operators they should clean the heat-exchanger surfaces to bare metal. There is evidence, too, that smoothness, such as may be obtained by applying graphite, also will retard formation of deposits.

The build-up of deposits on clean metal is generally slow in starting but increases rapidly, especially if measured as a draft loss. This is so because there is a fourth-power relationship, and doubling the thickness of the deposit increases the draft loss 16 times. Also, the flypaper effect that traps fly ash requires deposition of considerable material. This flypaper effect becomes more pronounced, especially in superheaters, as the deposit grows and its surface temperature increases. Some boilers develop very little deposit over a 1000-hr period and then suddenly go bad for these reasons.

The results of a survey do not show gradual degradation, as would be expected from immunity considerations. New air preheaters have had to be installed at intervals in some stations; and there is no trend of decreasing intervals, such as would be expected from an increasing SO_3 content in the flue gases. Also, there have been a number of cases of failure and forced outage of new boilers after a week or two of service.

CLEANING AIR PREHEATERS AND SUPERHEATERS

The British do not like on-load cleaning, and most operators do as little of it as possible. On the other hand, they will lance hot superheaters with cold water occasionally and state that little harm is done, even though the tubes eventually become distorted and corroded. At one station, on-load cleaning of air preheaters is done with air directed at the hot end. Regenerative heaters are cleaned off-load by washing the removed plates. Recuperative heaters are blown and washed in place. Steam-cleaning with ammonia is not practiced in England, and steam-cleaning alone is in disfavor because acidic deposits have caused pitting.

At least one instance of bonded deposits in a dry-bottom pulverized-fuel system has been ascribed to oil ash laid down during prolonged lighting-off periods, using inferior oils.

Dry-bottom pulverized-fuel furnaces can burn up to 3 per cent S coal without air-preheater trouble resulting, partly because the voluminous alkaline flyash takes up the SO_3. Also, the magnetite content of the spherules constitutes a reducing environment and discourages formation of additional SO_3. In addition, other physical and chemical factors, yet unrecognized, probably operate to prevent corrosion.

Contrary to popular belief, soot and coke do not promote sulphuric-acid formation. Instead, adsorbed sulphur trioxide is reduced to sulphur dioxide by carbon at 300 F.

The British have made about ten trials of Detroit Edison humidification and have secured benefit in only three cases of moderate fouling trouble with stoker-fired boilers. Humidification has been a complete failure in the other plants, some with similar and others with more acute fouling. In one plant slagging was reduced in the superheater, but not bonded deposits in the economizer. The British prefer flue-gas recirculation, which has been tried and found helpful in a few stations.

HOW THE BRITISH LIVE WITH THEIR PROBLEM

Official statements of the British Electrical Authority indicate a 99 per cent availability of boilers. This figure is arrived at by recognizing that some stations must have frequent scheduled outages for cleaning and no loss of availability is charged for the scheduled outages. Also, scheduled cleaning is not considered very expensive. In contrast, every effort is made to keep base-load plants on the line. They are supplied with special coals in so far as possible within the severe limitations imposed by costs and are rated very conservatively. Decreasing load is one generally successful way of keeping a boiler going longer between cleanings.

Very little change in design to obtain better availability is reported. Changes have been mainly in the direction of providing generously designed combustion chambers and recirculating flue gas. However, one new plant will have an expendable cast-iron auxiliary air preheater to serve as the cold end of its expensive air preheater. This already has proved to be worth while at an existing power station.

Tolerances and Specifications of GRAY-IRON CASTINGS

By C. O. BURGESS

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IN 1951 the gray-iron industry reached a new high of 14,897,000 tons of finished gray-iron castings as opposed to an estimated production of 65,000,000 tons of finished steel products. In other words, 1 lb of gray iron is employed in industry for every 4 to 5 lb of wrought steel. Although without question gray iron is the oldest of cast ferrous metals, it now constitutes 80 per cent of all cast products, and its use has increased proportionately over the past decade as compared to other ferrous and nonferrous metals either cast or in the form of weldments.

This continued expansion in the production of gray iron is based primarily on its unusual casting qualities combined with certain physical properties that have proved useful to industry. Gray iron possesses to a much greater degree than other cast or fabricated ferrous metals: (1) vibration absorption; (2) self-lubricating properties and ability to retain a surface oil film under adverse conditions (with consequent high resistance to wear and seizure); (3) low notch sensitivity; (4) comparatively high corrosion resistance to tap water and other mildly corrosive media; and (5) a controllable modulus of elasticity, based on the presence of graphite flakes, that minimizes distortion on heating or aging. It has a compressive strength approximately three times as great as the tensile strength, a response to heat-treatment comparable to that of eutectoid steel, and unusually favorable machining characteristics. Many of the foregoing useful properties are based on the presence of graphite flakes. Although some accommodation will take place through a small amount of plastic deformation of gray-iron castings, these same graphite flakes preclude the possibility of any considerable plastic flow or distortion. As in the case of other ferrous metals, the strength, wear resistance, and corrosion resistance of gray iron can be enhanced by proper alloying.

SPECIFICATIONS AND PROPERTIES

A large number of property specifications for gray iron exist, developed by the many and varied industries that employ gray-iron components.[1] By far the most generally accepted specification, however, is ASTM A48-50 which divides gray irons into classes on the basis of tensile strength, which run from Class 20 (20,000 psi tensile strength) to Class 60 (60,000 psi tensile strength) irons. Because of special castability requirements, necessity for freedom from chill, and similar factors, the chemical composition necessary to meet the required tensile specification is usually left to the foundryman. Castings are also generally required to be machinable, and under special circumstances, as in special grades of pipe, other properties, such as modulus of elasticity, may be specified. The modulus of elasticity can vary from extremes of 8,000,000 for a very high-carbon soft iron to 21,000,000 for a high-strength comparatively low-carbon gray iron. The vast majority of gray irons, however, have a modulus in the range of 15,000,000 to 19,000,000.

Considering castability characteristics alone, gray iron, as compared with other ferrous-base castings, has the highest fluidity or "life" and is, therefore, particularly adapted to production of intricate and comparatively thin-walled castings. This is, at least partially, due to its comparatively low melting point and the consequent long liquid interval before solidification is complete. Because it is a ferrous metal, gray iron tends to free itself of entrained gases and inclusions much more rapidly than light metals, such as aluminum and magnesium. Probably most important from a design viewpoint, however, is the low solidification shrinkage of gray iron which, depending on composition, varies from 0 to 1.9 per cent while the comparable shrinkage for steel, malleable iron, and nonferrous metals, such as aluminum or copper, is about 5.0 per cent. The contraction of gray iron after solidification, i.e., thermal contraction of the solid iron cooling down to room temperature, is about one half that of most other cast metals. These two factors—high fluidity and low liquid and solid shrinkage—mean that it is relatively simple and economical to obtain sound castings of intricate shapes and to hold close tolerances when gray iron is employed.

As presently produced, gray iron may be: (1) Statically cast into a sand mold, which, in turn, is produced by ramming sand around wood or metal patterns conforming to the final casting shape desired; (2) centrifugally cast into a sand or metal mold using centrifugal force to make the molten iron assume the exterior shape desired; (3) statically cast into permanent metal molds;[2] or (4) statically cast into thin-shell molds produced by dumping a mixture of fine sand and thermosetting resin over a heated pattern. Gray iron can further be readily cast using special precision or investment-casting methods although precision-casting of gray iron is comparatively seldom carried out commercially.[3]

AS-CAST TOLERANCES

By far the greatest percentage of gray iron is produced by static casting in conventional green or dry-sand molds. The average contraction of gray iron on cooling from solidification to room temperature under such conditions is considered to be 1 per cent or approximately $^1/_8$ in. per ft—about one half that shown by steel or nonferrous materials such as aluminum or brass. The wood or metal pattern used in preparing the mold is deliberately made oversize so as to allow for this normal contraction of $^1/_8$ in. per ft. This is known as the patternmaker's shrinkage.

Since the amount of shrinkage varies with the size of the casting and the resistance offered by the mold materials, this allowance obviously cannot be constant, and it is customary in the case of miscellaneous castings for the purchaser to allow dimensional tolerances approximately one half the maximum

[1] See "Summary of Gray Iron Specifications," Gray Iron Founders' Society, Cleveland, Ohio.

Contributed by the Metals Engineering Division and presented at the Fall Meeting, Chicago, Ill., September 8-11, 1952, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed.

[2] "Permanent Mold Gray-Iron Castings," by Edward C. Hoenicke, pages 551-552 of this issue.

[3] "Tolerances and Specifications of Precision Investment Castings," by W. O. Sweeny, MECHANICAL ENGINEERING, June, 1953, pp. 456-457.

shrinkage possessed by the cast metal, i.e., $\pm 1/16$ in. Thus a dimensional allowance of $\pm 1/16$ in. (0.06 in.) is a common specification with castings approaching a foot in final length. At this point it should be observed that it is important for the buyer not to specify closer tolerances than are absolutely necessary as delay and increased pattern and casting costs may result.

A study of production operations, including the preparation of sample castings, will permit closer tolerances to be used than the indicated figure of one half the maximum shrinkage. Based on experience with a particular product, many foundries are producing gray-iron castings to a tolerance of $\pm 1/32$ in. (0.03 in.). Small textile-machinery parts, small cams, camshafts, and intake manifolds are regularly held to similar tolerances. It should be realized, however, that a foundry cannot make a casting to closer tolerances than the quality of the pattern equipment will allow. If such close tolerances are required, it is necessary to use increased care in pattern preparation, usually to the extent of using aluminum matchplates or similar durable material.

The foundryman should be consulted in making the pattern since he is mainly responsible for maintaining tolerances. Wide experience with the grade of iron to be employed and the characteristics of his molding sands places him in the best position to advise the patternmaker as to the correct contraction allowance or patternmaker's shrinkage that must be provided. This shrinkage is not constant but depends on the number of cores used in a mold, on the over-all length of the casting, and varies with the casting weight. Table 1 shows how unit shrinkage varies with casting length.

Thus, total contraction and, therefore, dimensional tolerances do not increase numerically with increase in length. For example, although a tolerance of $\pm 1/16$ in., i.e., one half the contraction shown in Table 1, may be allowed on a casting 1 ft in length, the dimensional tolerance on a casting 3 ft in length would not be $\pm 3/16$ in. but probably closer to $\pm 3/20$ in. provided distortion is not a factor.

The effect of cores is even more marked, and in a heavily cored casting, such as a motor block, the shrinkage along the length may be $1/10$ in. per ft but zero in the height direction because of resistance offered by cores in the water-jacket section.

With certain highly repetitive jobs, such as automotive cylinder blocks, and so on, it has been found possible to hold tolerances up to an 8-in. span to $\pm 1/64$ in. (0.015 in.). Over 8 in., tolerances of $\pm 1/32$ in. are considered normal. The foundryman also will attempt to keep the controlling dimension entirely within one section of the mold and avoid crossing the mold parting line. Attainment of these closer tolerances is an example of the beneficial effect on tolerances of close co-operation between the foundryman, the patternmaker, and the designer.

In a few cases, captive foundries, working with very low-expansion sands and small parts, have been able to produce materials with remarkably close tolerances. For example, one producer of agricultural machinery reports that he is regularly casting gray-iron carburetor bodies of an average weight of $1\frac{1}{2}$ lb to within 0.004 - 0.005 in. of final dimensions.

TABLE 1 PATTERN SHRINKAGE ALLOWANCES FOR GRAY IRON[a]

Pattern dimension, in.	Contraction, in. per ft
Up to 24	1/8
25 to 48	1/10
Over 48	1/12

[a] A standard patternmaker's shrinkage for common gray cast iron is 1/8 in. per ft. For white cast iron shrinkage allowance averages 5/32 in. per ft. Allowances given in the table are quoted from "Specifications for Wood Patterns" formulated by a special committee of the Milwaukee branch, National Metal Trades Association, and published as AFA preprint 32-1, 1932.

Alteration of the casting method from static to centrifugal does not normally alter the usual tolerances as just noted. As might be expected with such a method, the outer-surface dimensions are held much closer than is possible with inside dimensions. One manufacturer reports that the outside of a 4-in-diam cylinder can be held to $\pm 1/64$ in. and the inside diameter to $\pm 1/12$ in.

One recently developed method that shows promise, concerning producing reduced as-cast tolerances that approximate finished dimensions, is the so-called shell-molding process. Unusually close tolerances of 0.001 to 0.002 in. per in. are claimed for this method. Tolerances of ± 0.003 in. to 0.004 in. on the diameter of an 8-in. gear have been reported. Although shell molding has reached commercial proportions for certain types of automotive castings that are produced repetitively in large quantities, it still must be considered in the development stage for the vast majority of standard gray-iron castings.

FINISH OR MACHINE TOLERANCES

The tolerances thus far outlined are those permissible for unmachined castings. If the castings require machining, it is common practice to allow 3/32 to 1/8 in. over the normal tolerance for removal in the machining operation. This permits two cuts being taken—a rough cut and a final fine finishing cut. The amount of extra stock allowed depends to some extent on the degree of machine finish required and the size of the casting. In the machine-tool industry where castings of 100 to 1000 lb weight are common, machining allowances of 3/16 in. to 1/4 in. usually are specified. This additional machining allowance also is advisable in the case of castings with one very long dimension where warpage may occur. In general, the larger the casting the more metal must be allowed for removal in machining since the increased heat in a large casting tends to promote burnt-in sand and a rougher than normal as-cast surface. Table 2 shows some common machining tolerances or allowances.

As in the case of as-cast tolerances, the foundryman in collaboration with the customer should continue to work to decrease machine-shop costs. With development of experience on a job, finish tolerances or allowances of less than the indicated 1/8 in. are possible. Cast bearings in the automotive field, for example, that must be turned down and ground, are made frequently with finish tolerances of 1/12 to 1/14 in.

The quantity of metal that must be removed from a casting by machining becomes of considerable economic importance if a great number of castings are handled per day. It is not unusual, therefore, for a casting purchaser to ask that the 1/8-in. allowance for machining be held to within $\pm 1/32$ in. even in the case of comparatively large castings weighing several hundred pounds. Quite often the amount of metal to be removed is designated on blueprints by special symbols such as f1, f2, f3, and so on, indicating, for instance, 1/8 in. 1/16 in., 1/32 in., and so on, is to be removed by machining or grinding. Incidentally, it is unfortunate that to date there has not been any standardization of these symbols by designers.

TABLE 2 GUIDE TO PATTERN MACHINE—FINISH ALLOWANCES FOR GRAY IRON

Pattern size, in.	Bore, in.	Finish, in.[a]
Up to 12	1/8	3/32
13–24	3/16	1/8
25–42	1/4	3/16
43–60	5/16	1/4
61–80	3/8	5/16
81–120	7/16	3/8
Over 120	Special instructions required	

[a] Surfaces to be machined should be located in the lower or "drag" sections of the mold for minimum machine tolerances. Additional finish allowances of 1/32 in. to 1/16 in. greater than shown may be desirable if certain upper or "cope" surfaces are to be machined.

If the part is simply to be disk-ground, the grinding allowance is always much less than the usual machining allowance, and at least for comparatively small castings may be specified as only $^1/_{32}$ in. The only way minimum machine tolerances of this order can be met is again by full understanding between the foundryman and customer.

TARGETING OR JIG LOCATIONS

Targeting or establishing jig locations on castings to be used as reference points for machining operations is a critical process. These targets may be in the form of one or more locating pads or specially ground, machined, or otherwise marked areas on the casting. Their exact location must be considered as a joint project of the casting user and foundryman. Only if the foundryman is informed (preferably by a drawing) how the casting is to be employed and how it must fit into other operating parts, can he do the best and most intelligent targeting job. For example, preferably he will select locations on the casting that can be held readily to the closest possible tolerances. To assure maximum accuracy, the pattern design also should be reviewed, the location of gates and risers, the effect of cores, and the possibility of placing the targets on one side of the parting line, all with the purpose of facilitating the final machining operation. In special cases where extreme dimensional accuracy justifies the extra cost, gages are employed for setting cores and for final measurements on ground target points. Using such precautions, it has been possible to hold target points within $\pm^1/_{32}$ in. in moderately sized castings.

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Permanent-Mold Gray-Iron Castings

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PERMANENT-mold gray-iron castings as produced by the author's company are of a modified gray-iron composition, cast into air-cooled permanent metal molds as they are carried through the casting cycle on a continuous rotating machine at a constant speed. After being designed and fabricated, the permanent molds are given two separate coatings which prevent the castings from adhering to the mold and reduce the thermal shock when the molten metal strikes the mold. The original or base-mold coating is a refractory clay on which is superimposed the second coating in the form of carbon smoke.

All permanent-mold gray-iron castings are processed through a complete annealing cycle at approximately 1575 F. The microstructure after casting consists of lacy eutectiform graphite, ferrite, and a small amount of pearlite. After the annealing treatment, the matrix is completely ferritic.

From this microstructure metallurgists and engineers would assume that the mechanical properties are low. This misconception arises from the fact that if ordinary gray iron, when sand-cast, is given a full annealing treatment to a ferritic matrix, tensile properties are in the range of 20,000 psi.

Tests made on permanent-mold irons and on permanent-mold castings consistently have shown much higher mechanical properties, and it is from this basis that we treat our subject as related to design, fabrication, dimensional tolerances, and control.

Castings of varied design are produced successfully in permanent molds and while the castings that have been produced cover a wide range of sizes and weights, and include both solid and cored types, in most instances slight modification from the original casting design has been necessary to facilitate extraction of the casting from the mold or to enable establishment of a straight-line parting of the mold which is always desirable.

Contributed by the Metals Engineering Division and presented at the Fall Meeting, Chicago, Ill., September 8–11, 1952, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed.

In the process the basic consideration, first, is the mold which must be designed for each individual type of casting. The casting design and tolerance are only as good as the mold is designed and fabricated. Certain primary factors in their proper relationship must be considered in obtaining good design. These are as follows: (1) Location of cavity, (2) core prints, (3) down sprue, (4) gates, (5) pouring basin, (6) mold vents, (7) risers, (8) overflow traps, and (9) metal thickness around the cavity.

Proper mold thickness is of great importance as it prevents localized hot or cold spots, which is a controlling factor in both mold life and sound casting. Formulas and rules have been developed to assist in designing the molds. The molds are hollow-backed with a boxlike wall with cavity thickness of $^3/_4$ in. to $1^1/_4$ in. depending on the amount of heat to be extracted from the casting. Cooling pins cover the back of the mold and are spaced to dissipate heat evenly and maintain uniform mold-face temperature.

The metal from which the permanent mold is made possesses a rather low modulus of elasticity, but has high plastic deformation. This type of iron gives greatest mold life. A large percentage of molds now produced are cast to exact size with regard to cavity, down sprue, gates, and risers. Gate sizes are usually 0.065 to 0.080 in. in thickness depending on individual jobs.

Castings of best design for permanent molding are those ranging in weight from $^1/_2$ to 12 lb and in size from 2 in. diam × $^1/_2$ in. thick, to 10 in. diam × 1 in. thick. Any combination of these sizes, plus others, which may be cylindrical in shape and up to 7 in. diam and the same in length, are practical, provided the interior is hollowed out and the resulting wall thicknesses are fairly uniform.

TYPES OF CASTINGS

Examples of types of castings produced by this method are worm gears, valve-stem guides, pulleys, hydraulic brake

cylinders, valve plates, valve bodies, connecting rods, compressor housings, and the like.

These castings cover mainly, automotive, refrigeration, air-conditioning, and miscellaneous appliances. Small radii are not desirable from the standpoint of short mold life while larger radii tend to increase the strength of castings through the elimination of abrupt changes between sections.

Castings whose contours necessitate small projections or protrusions from a large or main section reduce the mold life, because of a tendency of the mold to crack and burn out at these points.

A minimum of 3 deg draft on all contours is desirable.

A minimum wall thickness of $^3/_{16}$ in. is important and desirable.

Whenever small pockets and deep cavities can be eliminated, it eases production problems.

In so far as finish allowances are concerned customers require different allowances ranging from no finish to maximum of approximately $^3/_{32}$ in. where the castings may have warp tendencies on their flat surfaces such as sole plates for irons and large valve plates. On castings where there are contours and irregular shapes, the finish allowance may be considerably less, 0.060 to 0.075 in. being the average. Therefore it can be stated that finish allowances per surface range from 0.045 in. to approximately $^3/_{32}$ in. In general, the finish allowance can be minimized and reduced in this type of casting process because of the rigidity of the permanent iron mold.

TOLERANCES

Tolerances in the casting process are successful and practical at ±0.025 in. on the average-size work done in permanent mold. Here again the size of the casting is the determining factor coupled with contours and mass of iron. Castings of the small size like valve guides, valve bodies, or small refrigeration parts are cast at tolerances of ±0.015 in. without any trouble, while in castings of a large size, where pressures are created in the metal itself, the tolerances necessarily must be greater and exceed 0.025 in.

On cored work where the core is placed between the two halves of the mold and is completely surrounded by the high temperatures of the iron molds themselves, a problem of burn-in of the sand exists which is controlled by the size of the core plus a coating of core wash. This affords good resistance to the higher pouring temperatures. Similarly, the size of the core also determines the degree of burn-in that must be controlled because the degree of burn-in is related directly to the mass of iron surrounding it. A $^1/_2$-in-diam core can be used successfully in sections having thin walls, and conversely a large-diameter core can be used with heavier walls or sections, particularly where there is a heavy section on one side and a lighter section on the other.

Positive dimensional control must be maintained on cores and core prints since cores are set in a permanent iron mold where the core is held tightly with no place to go if it had to move slightly. Since crushing by the iron mold might take place, the need for accurate dimensions is obvious. Another control that must be exercised is the relationship of the core print to the core itself since the core is hung in a vertical position in the mold. Without this proper relationship the core section may be thrown off location and therefore results in shifts and thin wall sections.

PHYSICAL AND MECHANICAL PROPERTIES

In the category of specifications the physical and mechanical properties may best be reviewed by using the information produced from one of our engineering research studies.

Using the 1.2-in. test bar in all cases for comparative purposes the following is indicated: (1) Tensile strength range, 30,000 to 33,000 psi; (2) tensile modulus of elasticity, 13.60 × 10^6 psi.

In the foregoing test for tensile properties the test bars were machined as follows:

The diameter of the reduced section was 0.075 in. for the 2.0-in. and 1.2-in. test bars; 0.5 in. for the 0.875-in. test bars and 0.375 in. for the 0.5-in. test bars.

The dimensions of the tensile specimens were standard and were taken from the recommendations of the American Society for Metals. Four bars of each category were broken and the results averaged.

In order to avoid criticism of the use of a reduced section of 0.75 in. for the 2.0-in-diameter bars, three additional sets were machined from the 2.0-in. bars having reduced sections of 1.25-in., 0.5 in., and 0.375 in., respectively. The test run expressed in psi ran from 22,000 to 22,700, proving that the diameter of the test specimen does not influence appreciably the tensile test values obtained as is the case with sand-cast iron. In other words, permanent-mold iron is somewhat more uniform in characteristics over a range of section sizes than normal gray cast iron.

3 Brinell hardness range, 170 to 207. Little appreciable difference in Brinell hardness between bars of different diameters was found in the test.

4 Compressive-strength range, 99,000 psi on a 2-in. bar to 124,000 psi on a 0.5-in. bar. There was no marked irregularity in the results among any one group of specimens taken on four individual determinations. The fractures were exceptionally clean-cut, showing the 45-deg shear planes clearly.

5 In the test for torsional properties the following was found: (*a*) Shear stress at yield point ranged from 19,000 to 23,000 psi on bars from 0.875 in. to 2 in. diam; (*b*) shear stress at rupture ranged from 36,000 to 44,000 psi on bars from 0.875 in. to 2 in. diam; (*c*) torsional modulus ranged from 6.310 × 10^6 to 7.435 × 10^6 psi on diameters from 0.875 in. to 2 in.

6 In the bending or transverse-properties test the following was found using four diameter bars from 0.5 in. to 2 in.: (*a*) Breaking-load range, 600 lb on the 0.5-in. bar to 8000 lb on the 2-in. bar; (*b*) deflection range, 0.178 in. on the 0.5-in. bar to 0.240 in. on the 2-in. bar; (*c*) modulus of rupture, 99,000 psi on the 0.5-in. bar to 63,000 psi on the 2-in. bar; (*d*) bending modulus, 19.60 × 10^6 psi on the 0.5-in. bar to 14.87 × 10^6 psi on the 2-in. bar; (*e*) breaking energy, 72 in-lb on the 0.5-in. bar to 1200-in-lb on the 2-in. bar.

7 Fatigue-endurance limit ranged from 32,000 psi on a 0.5-in-diam bar to 13,500 psi on a 2-in-diam bar.

8 Heat-treated tensile strength ranged from 82,000 psi on a 0.5-in-diam bar to 32,000 psi on a 2-in-diam bar.

9 In testing for growth the per cent of increase in volume was found to range from 0.133 per cent on a 0.5-in. bar to 0.33 per cent on a 2-in. bar, indicating that the per cent increased with the increase in the diameter size being tested.

CONCLUSION

In general, the high deflection in this type of iron is due to the uniform continuity of the ferritic matrix.

Porosity and segregation are absent because of rapid solidification producing a dense tight metal owing to rigidity of the mold face preventing conversion of combined carbon to graphite and the rapid extraction of heat during the period of solidification which produces an extremely fine graphite pattern.

In summary it can be said that with physical and mechanical properties displaying consistency, and operational control beginning with the permanent mold for dimensional accuracy, castings produced by the permanent-mold process lend themselves to greater uniformity of dimensions and tolerances.

THE ASME BOILER CODE

VIII Revisions by Annulment of Cases—1936–1937

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THE short period between the editions of all of the Sections of the ASME Boiler Code was not due to change in the practice of boiler construction and surely it was not in harmony with the announced policy of curtailing frequent changes in the rules which resulted from the many complaints regarding its actions between 1931 to 1935. It resulted, from the fact that in 1936 there were too many active interpretations that had not been transferred to the Code and hence reference to these replies for justification of procedures by the Committee or by users was difficult. The Boiler Code Committee had replied to 815 cases by the end of 1936. On Feb. 28, 1936, E. R. Fish presented a list of the numbers of inactive cases as of Jan. 1, 1936, which totaled 645 cases while the active cases numbered 166. The need for the annulment of the inactive cases and the transfer of some if not all of the active cases into the Code was evident. Thus during the years 1936–1937 the minutes of the 18 meetings of the Committee and other minutes of the Executive Committee are filled with records of annulments by revisions to the Codes or by simple dropping. On Sept. 18, 1936, V. M. Frost reported on 12 cases which should be annulled because they had been incorporated into the Code by previous revisions as well as other cases which should be annulled, with reasons for such action. This left 141 active cases.

On Oct. 16, 1936, it was reported that H. E. Aldrich, E. R. Fish, and V. M. Frost had studied the list of active cases as adopted and had found that there were still some which could be annulled. They prepared a list of those which could be annulled and cited the proper manner for this action in 31 cases, which left the active list with 88 cases. This number was reduced in 1937 to about 30 active cases, eliminating the need of extensive study to find an earlier interpretation which would apply to a new inquiry or communication.

The average attendance at the 18 regular meetings of the Committee was 18 of the 24 members, an excellent record, with three from the Conference Committee, six non-Code Committee members of Subcommittees, and three guests. The representative from the Steamboat Inspection Service was present at 11 meetings and the representation of the Bureau of Engineering, U. S. Navy attended 11 of the 13 meetings before the Bureau discontinued the practice of having representation at all Committee meetings.

During this period there were four conference meetings on tubes and gages, on safety valves, with the Ohio Board of Safety Rules, and on specification S-27.

CONFERENCES ON TUBES AND GAGES OF TUBES

Dr. D. S. Jacobus advised the Boiler Code Committee at its meeting on Feb. 28, 1936, that the tables for the gages of tubes for the Power Boiler Code, the Code for Boilers of Locomotives, and the Code for Unfired Pressure Vessels had been studied with considerable care by the Executive Committee. He presented as a progress report a proposed formula for the allowable working pressure on seamless tubes and one for minimum thickness. These included an allowance for corrosion. This proposal permitted working pressures for tubes for unfired pressure vessels for the same gage and outside diameters 100 psi greater than those for power boilers. The report was accompanied by three charts of allowable working pressure for different thickness of water tubes of 4 in. OD, $3^1/_4$ in. OD, and 2 in. OD. The charts showed curves for the present tables for seamless and lap-welded tubes for boilers, the proposed tables for seamless tubes for boilers and for unfired pressure vessels, and the values from the German Standard for steels of tensile strengths of 49,800–64,000 psi and of 64,000–78,000 psi. The German Standard has been mentioned earlier.

As E. R. Fish and D. S. Jacobus believed that the proposed formula of February 28 gave an excessive allowable pressure for the tubes, a second progress report was made and a second formula was added (March 27, 1936). In using the two formulas the lower resulting value of the working pressure would be selected for a given diameter and gage. The two formulas give the same gage at about 740 psi. The second progress report included the three sets of curves presented in the first progress report. The report also stated that another rule for determining the minimum gages was under consideration and hence no publication should be made at that time.

The Executive Committee of the Boiler Code Committee met on April 10, 1936, with D. S. Jacobus, chairman, W. H. Boehm, E. R. Fish, H. E. Aldrich, V. M. Frost, C. E. Gorton, and C. W. Obert present as well as C. A. Adams, H. B. Oatley, and A. C. Weigel of the Main Committee. Dr. Jacobus presented a proposed table for the allowable working pressures for seamless steel tubing for water-tube boilers dated April 9, 1936. He explained the development of the tables in the then existing Codes and their use for seamless as well as lap-welded tubes. The proposed tables were for seamless tubes, and if these were adopted, similar tables could be developed for other types of tubes. The same charts for 4-in., $3^1/_4$-in., and 2-in. tubes as reported earlier were shown as well as others for $5^1/_2$-in., $1^1/_2$-in., and $^1/_2$-in. tubes.

In the discussion of the treatment of other types of tubes it was announced that an informal conference would be held with representatives of tube manufacturers on April 20, 1936. For the purposes of presenting a program to the conference the Executive Committee accepted the proposed table with the understanding that the minimum gages for different diameters given in the table were the minimum which should be used at all lower pressures and that the thicknesses for higher pressures should be determined by the formula using the next higher unit of 10 above the value determined by the formula. The Executive Committee also voted that a new rule would be proposed that for tubes exposed to radiant heat the thickness should be one gage heavier than that given in the proposed table. It tentatively proposed that tubes welded by the electric-resistance process be given a working pressure of 90 per cent of that in the table and that lap-welded tubes of Tables P-2 and

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Chapter 8 of a history of the ASME Boiler Code, prepared for the Boiler Code Committee of The American Society of Mechanical Engineers. Other chapters appeared in MECHANICAL ENGINEERING, July, August, September, November, and December, 1952, and February and March, 1953.

P-3 should remain as they had been except that they should be changed to the next higher unit of 10.

The Executive Committee, including James Partington, met with F. B. Howell, H. B. Oatley, and A. C. Weigel on April 20, 1936, to confer informally with the following representatives:

James Collins (Subcommittee on the Rules for Inspection), J. S. Adelson (Steel and Tubes, Inc., Cleveland, Ohio), F. J. Boehm (Steel and Tubes, Inc., Brooklyn, N. Y.), H. S. Carland (Reading Iron Co., New York, N. Y.), L. B. Gindlay (Republic Steel Co., Youngstown, Ohio), Newell Hamilton (Babcock and Wilcox Tube Co., Beaver Falls, Pa.), L. M. Hogan (Steel and Tubes, Inc., Cleveland, Ohio), P. C. Lewis (Globe Steel Tubes Co., New York, N. Y.), W. M. Neckerman (Republic Steel Co., Youngstown, Ohio), H. R. Redington (National Tube Co., Pittsburgh, Pa.), W. J. Sampson, Jr. (Steel and Tubes, Inc., Cleveland, Ohio), J. J. Shuman (Jones and Laughlin Steel Corp., Pittsburgh, Pa.), A. Voupaieff (Reading Iron Co., New York), G. E. Wearn (Republic Steel Corp., Cleveland, Ohio), and L. H. Winkler (Bethlehem Steel Co., Bethlehem, Pa.).

Dr. Jacobus explained the development of the original tables and the reasons for and desirability of revisions. Originally, the table was intended for lap-welded tubes for water-tube boilers with no reference to pressures, as they had been based on the practice of that time. When separate tables were published for tubes of water-tube boilers there was no reference to use of tubes of lesser thickness than those shown in table. The addition of 0.039 in. in the formula was made to secure stability and to care for corrosion. Then the table was used for seamless tubes until it was appreciated that at higher pressures there should be a difference and rules represented by the two formulas were added to the Code for lap-welded tubes.

The chairman of the Executive Committee stated that for the two preceding years (1934-1935) the Boiler Code Committee had been considering a revision of the tables and distributed the tentative table of pressures with the five charts showing the results of the formula compared with the present formulas and the German Rules, emphasizing their tentative nature and asking for the co-operation of the tube manufacturers and others in the preparation of the tables.

In response to inquiries it was stated that the tables might be published in MECHANICAL ENGINEERING for comments and suggestions after agreement had been reached. This would not mean adoption at once as one adverse criticism had frequently held up adoption. The relation between welded and seamless tubes should be discussed as well as the use of heavier tubes for those nearest the fire. The present Code lacked rules regarding superheater tubes.

The effect of reducing the present gages of tubes on the business of the manufacturer was brought up by the Boiler Code Committee and P. C. Lewis and J. J. Shuman expressed the belief that the decrease would be satisfactory.

Discussion of the difference between the requirements for safe thickness of seamless tubes and welded tubes was extensive and enlightening. J. S. Adelson presented data on electric-resistance-welded tubes showing that hydrostatic bursting tests of long and short lengths had shown that fracture generally occurred outside of the welds and the tubes usually expanded 1/4 in. before rupture. He also pointed out that the electric-resistance weld introduced no different metal between the parts as was done in fusion welding. W. M. Neckerman announced that the similar method of his company had produced such tubes for seven years for oil-line piping and well casing with the same allowance for fiber stress as was given for seamless tubes. These tubes and pipes had been used for many miles of piping with high-pressure gas, gasoline, and oil, and it was pointed out that API specifications required a transverse test to be made to show the same tensile strength as that of the base metal. Both Messrs. Adelson and Neckerman urged an efficiency of 100 per cent for this method of welding.

J. A. Collins called attention to two failures of butt-welded tubes of a water-tube boiler inserted without the knowledge of his insurance company. J. S. Adelson advised the conference that these tubes had been made by his company and that they should never have been shipped from the plant because the inspection had been improper. The method was not at fault as inspection could be made of each side of the welds. The tubes which failed would have been rejected had the proper inspection been made. Since their tubes were sold on the same basis as seamless tubes they could not accept a lower rating.

L. M. Hogan stated that although the time available at the meeting was too short to determine from comparative data of service records the equality of methods of weld, the use of 90 per cent efficiency would be a reflection on their method and he requested earnest consideration of the matter.

L. H. Winkler discussed the lap-welded tubes of his company and said that to his knowledge no weaknesses had developed. Their tests of lap-welded tubes had indicated ample strength at the welds. The welded portion was as strong as the skelp from which the tube was fabricated; their method had been developed first for lap-welded products and then for tubes. He offered to present to the Boiler Code Committee data showing strength transversely to the weld. The length of the weld used by them was between 4 to 5 times the wall thickness and did not present any more of an element of weakness than the other variables which might exist in a tube of other makes such as under gage at points not recognized in inspection. Such conditions could not exist in lap-welded tubes. For these reasons, he said, if the tables were too conservative for seamless tubes they were equally too conservative for lap-welded tubes. J. J. Shuman inquired the intent of the Committee regarding the retention of the formulas for lap-welded tubes in the latest edition of the Code. The present values for lap-welded tubes, he said, appeared to be quite different from the proposed values for seamless tubes.

D. S. Jacobus pointed out that differences of opinion were so great that retention of the tables for lap-welded tubes might be better than the development of a new formula. Mr. Winkler, in response to a question, stated that present-day practice in the use of better steels, improved processes, inspection, and other details had improved the properties of lap-welded tubes. H. E. Aldrich pointed out the relatively limited use of lap-welded tubes for water-tube boilers and said that insurance companies and inspectors did not favor their use in such boilers. He believed that such tubes are satisfactory in fire-tube boilers and they should be given the same pressure values as other tubes when subject to collapsing pressures. E. R. Fish stated that the principle failures of lap-welded tubes occurred in the welds because, unfortunately, the method of manufacture permitted imperfect welds to be passed. After the manufacturers' tests for approval, the changes of pressure and temperature in use allowed undetected defects to gradually open up, resulting in serious accidents. Although the Code did not prohibit the use of such tubes in water-tube boilers, he said, such use was decreasing and would probably disappear.

When the question of increasing the thickness by one gage for tubes exposed to radiant heat was discussed, J. A. Collins expressed his objections to any reduction from the present requirement in the thickness of tubes for water-tube boilers and pointed out that the thicker tube would stand more corrosion. An error would be made in economy and safety from such reduction, and he stated, the Commonwealth of Massachusetts would not make such a reduction in its rules. Although present tubes were operating at a higher factor of safety, he was

certain that it was a satisfaction to the insurance interests that tubes were sufficiently heavy and were without the possible hazard of tearing from thinner tube ends.

James Partington called attention to the higher pressures used on locomotive boilers and said that the increase in gage from 11 to 10 could not be explained scientifically but safety must be considered as well as the careful scrutiny of weight.

A. C. Weigel pointed out that under the early codes boilers were constructed with large tubes for low pressure, whereas for the present the rules would prevent the use of boilers with forced circulation used abroad with success and being built in this country at that time.

H. B. Oatley called attention to the higher temperature of the metal in tubes subject to radiant heat and in superheater banks, not appreciated in the earlier Codes. The specifications for tubes materials, he said, might require revision to include testing materials at elevated temperatures to determine suitability.

Participation by the guests at this important conference was greatly appreciated and the Executive Committee expressed this by a vote of thanks. The Boiler Code Committee decided to report to the conference but to take no action at their meeting except the approval of the increase of 100 psi to the tabular values for tubes of unfired pressure vessels and the rounding out of the values of Table 2 to the next higher figure ending in zero.

On May 27, 1936, the values in Table 5 for fire-tube boilers of the Power Boiler Code and Table L2 for Boilers of Locomotives given in the edition of 1935 were questioned. Suggested changes using the Stewart formula were approved but publication was withheld until the tables for water-tube boilers were established. On the recommendation of James Partington, however, the use of Table L2 for locomotive boilers was approved as an addendum because of the increase of pressure in boilers of this type.

This Table L-2 had been studied by D. B. Wesstrom and he questioned (executive sessions, June 26, 1936) the use of an apparent factor of safety of three for some tubes and a factor of five for others, pointing out the early renewal of the thinner tubes and the more frequent failures due to localized conditions in the furnace. These objections were believed to result from a misinterpretation of the application of the table and its relation to the present table and James Partington, chairman of the Subcommittee on Boilers of Locomotives, was directed to reply to Mr. Wesstrom.

At the executive session of the Committee of June 26, 1936, test data from one of the manufacturers of lap-welded tubes was reported, and as some of the manufacturers of electric-resistance-welded tubes had indicated acceptance of 90 per cent efficiency of weld, it was suggested that it would be advisable to indicate to the manufacturers of lap-welded tubes the efficiency the Boiler Code Committee had proposed for their product. The exclusion of lap-welded tubes for use in water-tube boilers was discussed.

On Oct. 16, 1936, Dr. D. S. Jacobus reported a new table for the maximum allowable working pressure for seamless steel tubing for water-tube boilers and presented prints illustrating the method for determining the working pressure which would meet objections which had been made. The formula used had been developed by Perry Cassidy following a thorough study of this entire subject. The minimum thicknesses for tubes 2-in. outside diameter and under were the same as the present Table P-2, whereas the allowable working pressures for $3^1/_2$-in. and 4-in. tubes of minimum allowable thickness were above those of Table P-2. The required wall thickness for 1400 to 2000 psi working pressure were considerably less than would be obtained by the formula used for computing the values of the present Table P-2. The formula proposed and used for the table was strictly scientific, embodying as it did the allowable working stress for the material forming the tube which varied with different steels. The wall thicknesses at high pressure approached those given in the table reported to the Conference in April, while the thickness for smaller diameters conformed with practice. Dr. Ernest Lupberger, originator of the German rules for boiler tubes, reported to Dr. Jacobus at the World Power Conference in Japan that their rules had been in use for six years without a tube failure attributable to insufficient thickness. The comparison of the proposed table requirements with these German rules showing higher allowable working pressures were presented to the Boiler Code Committee as was done with the proposed table shown at the April Conference.

Perry Cassidy explained the significance of the chart which formed the basis for plotting the values of the working pressures for seamless tubes. On this chart pressure divided by the stress was the ordinate and thickness divided by diameter was the abscissa. Such a chart could apply to the German or American formula. On such a chart the Barlow formula became a straight line. The Lamé formula, the more accurate in the elastic range, required less thickness than the formula devised by him when the thickness was equal to $2^1/_2$ per cent of the diameter. On his diagram he had purposely selected his line to pass through the 4-in. 10-gage tube with the working pressure of the present Code. He then discussed other features of his proposed curve and stated that only at the extreme range did it cross the Barlow line. The relation of this curve for high pressures and the effect of temperature stresses in radiant parts was explained.

After discussion, including consideration of welded tubes, the publication of the table was referred to the Executive Committee with power, after the deletion of one point and the inclusion of a statement that a rating of 90 per cent should be given to electric-resistance-welded tubes and 80 per cent for lap-welded tubes, provided the data submitted warranted these particular ratings.

On Nov. 20, 1936, it was reported that since the October meeting the Executive Committee had given consideration to the form in which the table for the gages of tubes should appear in MECHANICAL ENGINEERING. Certain changes discussed in October had been made and Perry Cassidy had been requested to prepare an article to accompany the table. This publication of the table and article in MECHANICAL ENGINEERING for January, 1937, brought protests from the Ohio Board of Boiler Rules and from those interested in electric-resistance welds which indicated another public hearing should be held. The Ohio Board stated that there were not sufficient data presented to warrant a change in the present table.

The Second Conference occurred on March 11, 1937 with 13 members of the Boiler Code Committee, Perry Cassidy and J. A. Collins, members of Subcommittees, and 19 guests. J. A. Adelson, Newell Hamilton, L. M. Hogan, P. C. Lewis, W. J. Sampson, Jesse J. Shuman, G. E. Wearn, and Louis H. Winkler had attended the conference of April 1936. The new representatives from the manufacturers were: Arthur R. Adelberg (Timkin Steel and Tube Co., New York, N. Y.), Thomas B. Allardice (American Gas and Electric Co., New York, N. Y.), Prof. A. G. Christie (The Johns Hopkins University, Baltimore, Md.), Leonard W. Harston (Steel and Tubes, Inc., Cleveland, Ohio), Benjamin P. Hazeltine (Wheeling Steel Corporation, Wheeling, W. Va.), Harry B. Lilley (Timkin Steel and Tube Co., Canton, Ohio), W. A. Shoudy (New York, N. Y.), Frank N. Speller (National Tube Co., Pittsburgh, Pa.), Thomas G. Stitt (Pittsburgh Steel Co., Allenport, Pa.), J. W. Wilson (Bureau of Navigation and Steamboat Inspection, Washington, D. C.), and Ralph L. Wilson (Timkin Steel and Tube Division, Canton, Ohio).

The purpose of the second conference was to obtain from all

interested parties comments on the proposed revisions of the table for allowable working pressure on tubes for water-tube boilers. Many letters had been received, including some to the President of ASME, James H. Herron, objecting to the action on electric-resistance-welded tubes. Dr. Jacobus pointed out that letters and oral suggestions would receive careful consideration. The first question to be considered was the suitability of the published table for seamless tubes.

J. W. Wilson stated that seamless tubes had been approved by the Bureau of Navigation and Steamboat Inspection since 1931 and that electric-resistance-welded tubes had also been approved. At the time of the latter approval there had been no discrimination between tubes for water-tube or fire-tube boilers. The use of electric-resistance-welded tubes under their revised code for fire-tube boilers had been objected to by manufacturers. Certain tests were made proving the reliability of such tubes and they were allowed the same rating as that for seamless tubes. The American Bureau of Shipping and Lloyd's Register of Shipping had also recognized the tubes as a marine standard. He also approved the new table for seamless tubes and was of the opinion the same rating should be allowed welded tubes.

J. A. Adelson noted that the use of the formula resulted in tubes which were quite thin for the smaller tubes, thinner than those in the old table. He thought the formula should be revised to result in a heavier gage for tubes of smaller diameter. He questioned the allowance for corrosion, especially in small installations. In reply to a question from E. R. Fish he stated that with thinner tubes the rolling operation in expanding would result in walls too thin when the operator was not adept. A $^1/_2$-in. tube of 18 gage was supposed to be good for 1200 psi which he thought was very high, especially when corrosion was considered. In addition to his remarks a very complete letter from the vice-president of Steel and Tubes, Inc., L. W. Harston, gave a complete story of their product. The letter pointed out the properties of the product, the successful service of the finished inspected product in boilers and automobile drive shafts. It also stated that the offer of the company to bear the expense of any tests which the Boiler Code Committee would desire by an independent testing laboratory indicated clearly why the company strenuously objected to the reduction of the allowable working pressure of its tubes to 90 per cent of that allowed on seamless tubes.

Some of the representatives of seamless tubes expressed their satisfaction with the approved tables, but John A. Collins stated that he had heard no reasons given why the old table should be revised. The insurance interests of the Massachusetts Board of Boiler Rules, which he represented, were concerned with tubes from 2 in. to 4 in. in diameter and not with other sizes for high-pressure boilers. In some of the sizes in which they were interested increases in pressure of from 43 to 59 per cent had been made in the table. The saving in weight would be a false saving and work a hardship on purchaser and insurance companies due to the cost of outages. He related experiences with boiler tubes under 700 psi of 5 gage which ruptured when reduced to a thickness between 7 and 8 gage. This rupture was so small in one case that it resulted merely in a breakdown, but in another similar case such a rupture would have led to the explosion of a number of other tubes. He felt that there were sufficient ruptures then without reducing the thickness which would cause more. He also called attention to the fact that the Massachusetts Board of Boiler Rules could not sanction the change and that this would restore the old state of nonuniformity.

The discussion of the proposed requirement of the 90-per cent allowance for tubes welded by the electric-resistance method brought out questions regarding the percentage of discovered defects. By this method of welding these might amount to one per cent of tubes made but not of the finished annealed and inspected tubes. Examinations of many tubes which had been in service with temperature changes had never revealed any changes in the structure of the metal. The statement of Frank N. Speller that a "weld is a weld," was objected to by W. A. Shoudy, as welding was already being done for pressures of 1400 psi and he was using pipe for 600 psi. The process of welding was different for different pressures, he said, and supervised welding meant more than just welding two pieces together.

C. A. Adams pointed out that with x-ray examination of the welds in drums an efficiency of 90 per cent was allowed after defects had been removed and stated that it would be inconsistent to permit 100 per cent for welding for which such care had not been exercised. In answer to this J. A. Adelson reported on tests in the presence of the inspector of a customer where tubes from three seamless manufacturers were tested with some with electric-resistance welds. The seamless tube from one manufacturer failed because of seams in the metal while none of the welded tubes failed. A seam was just as detrimental as a defective weld.

The discussion of lap-welded tubes brought out the fact that the present Marine Rules of the government allowed their use for fire-tube boilers where the tubes were under compression, but the manufacturers of such tubes stated that their welds had strength equal to that of the tube wall and that lap-welded tubes had been used for new boilers in many places. The failures of such tubes was reported as being very low.

In answer to a question about the elimination of the rib formed in electric-resistance-welded tubes J. A. Adelson told of the progress in removing this to within 0.015 in. Complete removal was their hope. He also stated that the practice of annealing reduced the strength 10,000 psi to the value of 45,000 psi for the parent metal, using steel with a maximum of 0.18 per cent carbon.

Thomas B. Allardice suggested the advisability of using the old table and restricting the proposed table to pressure above some pressure such as 1000 psi, while A. C. Weigel suggested 900 psi, just above the limiting point for lap-welded tubes. This phase of the subject was also discussed by others.

In reporting this conference to the meeting of the Boiler Committee the next day, March 12, 1937, Dr. D. S. Jacobus mentioned the fact that some believed that the present table should be used for lower pressures but that the revised table be used for higher pressures, the starting point to be determined. For forced circulation there was no objection to the revised table when tube ends were welded to the headers and the feed water was such that a material amount of corrosion would not occur. H. E. Aldrich advised that it had been brought out that no distinction was made in the type of tube when used in fire-tube boilers where the tubes were subject to compression. He expressed the opinion that no action should be taken on the table for fire-tube boilers until the table for water-tube boilers had been adopted.

The Boiler Code Committee decided to take no further action at that meeting and to leave the matter in the hands of the Executive Committee.

In the discussions over the conference matters the amount of metal for expanding ends of smaller tubes was considered as well as the amount of metal for corrosion. This brought up the necessity of a note to the effect that with small tubes and forced circulation the feedwater must be of high quality.

The action of the Executive Committee on April 7, 1937, was reported to the Boiler Code Committee on April 16, 1937. The communications received following the publication of the table and article by Perry Cassidy in MECHANICAL ENGINEERING for January had been given careful review, and from these and

the minutes of the Conference of March 11 the Executive Committee believed that the revised table was approximately correct for the higher pressures. In view of the opinion of some of the boiler inspectors and others, it appeared that it was not necessary to revise the present values for lower pressures. A revised table prepared by Perry Cassidy for the Executive Committee was presented. This table covered seamless tubes of water-tube boilers made of Grades A, B, and C of steel of specification S-17 or electric-resistance-welded tubes of Grades A and B of specification S-32. Action on this table was referred to the Executive Committee.

The Boiler Code Committee (Oct. 28, 1937) authorized the publication of the Table P-2(*a*), reported at the April Meeting, in MECHANICAL ENGINEERING omitting all values for pressures under 1000 psi with a note that for lower pressures the present tables could be used for seamless and welded tubes.

These suggested changes were made after the revisions for the 1937 edition had been included so that the Tables P-2 and P-3 appeared as in the edition of 1935 with the exception that the last figures of allowable pressure had been rounded out to the next higher number ending in zero.

CONFERENCE ON SAFETY VALVES

The relieving capacity of safety valves had caused much concern to the National Board of Boiler and Pressure Vessel Inspectors. C. O. Myers reported on Jan. 17, 1936, that the National Board had had a recent series of tests conducted for it at The Ohio State University on three types of safety valves which it had purchased in the open market for the purpose of checking their stamped relieving capacities. He reported that none of these values complied with the present Code requirements and then gave a short report of the data from the tests. He stated that when these facts were reported to the manufacturers they requested the opportunity to submit valves for tests and these also did not fully meet Code requirements.

The National Board then decided to require all safety-valve manufacturers furnishing valves for use in states and cities having membership on the National Board to build in accordance with Code rules and in addition to comply with certain test requirements. Two valves of each type manufactured, one the smallest size and the other, not to exceed $2^1/_2$ in. in diameter, and for a popping pressure not to exceed 150 psi, were to be submitted to the Board for test. Detailed drawings were to be supplied with tables showing lift and relieving capacity. The expenses of the tests were to be borne by the manufacturer. The manufacturer might have a representative present at the tests. All safety valves installed should be tested, approved and stamped National Board.

The importance of this situation was such that a Special Committee, consisting of H. B. Oatley, chairman, V. M. Frost, and C. O. Myers, was appointed to co-operate with the National Board in considering revisions of Code to cover inspection of safety valves or other necessary requirements for such valves. Prof. Paul Bucher of The Ohio State University was appointed to the Special Committee on Feb. 28, 1936. The chairman, H. B. Oatley, reported at the meeting of the Special Committee on Feb. 27, 1936, that revisions to Pars. A-12 to A-17 would have to be made and that it had decided to call a conference with the safety-valve manufacturers on March 26, 1936, for discussion of these matters.

This conference of March 26, 1936, was held at ASME Headquarters with representatives of the Safety Valve Manufacturers' Association for the purposes of considering the data from the tests made by the National Board and the necessary revisions to the safety-valve requirements of the Code to correct deficiencies which had appeared. The representatives were cooperative and the discussion was favorable to revisions. The deletion of Par. A-11 and parts of Pars. A-13 to A-16 which could be made then were approved, while the other proposed changes would await formulation by the Special Committee. Reference about change in Pars. A-44(*b*) and P-275(*e*) resulted in alterations to correspond with the earlier action.

The Special Committee reported on the revisions of parts of the Codes relating to safety valves and safety-valve tests on Sept. 18, 1936, following a number of meetings with representatives of the safety-valve manufacturers.

The report, dated Sept. 14, 1936 included revisions affecting 14 of the paragraphs between Pars. P-270 and P-289 with recommendation that some of these changes should be made in the Sections on Boilers of Locomotives, on Low Pressure Heating Boilers, on Miniature Boilers, and on Unfired Pressure Vessels. The changes in Pars. P-270 to P-272 were for clarification, except that in Par. P-272 the maximum rated steam capacity was to be determined by the actual steam flow in the presence of an inspector and not by the formulas of Par. A-11 which had been deleted. Par. P-273, manufacturers' markings, was extended slightly, but ten paragraphs of instructions regarding use of the symbol and the tests were added. These were the most significant changes. Similar changes were made to Pars. P-281 and P-282 on valve action and to Par. P-284 on springs, while minor changes were made to Pars. P-287 and P-289.

The representatives of the Safety Valve Manufacturers' Association believed that they could furnish data which might warrant some modification in the revisions proposed. The report was adopted for publication in MECHANICAL ENGINEERING for comment. The changes appeared in the 1937 edition of Section I with changes made on Dec. 19, 1936.

CONFERENCE WITH OHIO BOARD OF BOILER RULES

At the Boiler Code Committee meeting of Dec. 18, 1936, a letter dated Dec. 2, 1936, from L. E. Connelly, chairman of the Ohio Board of Boiler Rules, was presented to the Committee. In this letter, exception was taken to the statement which had appeared in MECHANICAL ENGINEERING preceding the interpretations of the Code, that any one desiring information on the application of the Code should communicate with the Secretary of the Committee. This, Mr. Connelly believed, suggested that the Committee solicited requests for interpretations. Mr. Connelly further advised the Committee that his Board had gone on record that the Committee interpretations would not of necessity be accepted by them although the final interpretation of the meaning of specific paragraphs should still be in the hands of the Boiler Code Committee. When information regarding application was desired the first request should be made to an administrative body. If the Code was not clear, he believed the request should come from the administrators to the Committee. To clear this matter he suggested a conference of representatives of the Committee with the Ohio Board of Boiler Rules at its meeting of March 3 and 4, 1937.

In accepting the invitation, the procedure mentioned in the December (1936) issue of MECHANICAL ENGINEERING was noted as one which had existed since 1916 and that the objection of the Ohio Board was the first made against this practice.

The Special Committee, D. S. Jacobus, E. R. Fish, and H. E. Aldrich, met with the Ohio Board of Boiler Rules on March 3, 1937. The full Board, L. E. Connelly, chairman, J. L. Scott, J. H. Vance. R. W. Parry, and C. O. Myers, were present and cordially greeted the representatives of the Boiler Code Committee for a frank exchange of views relative to the Code leading to a better understanding and co-operation between the Committee and the Board. No notes were taken and the representatives of the Committee pointed out that they could only give personal opinions as Committee action would be required for the approval of definite actions.

Mr. Connelly explained the legal requirements under which the Ohio Board operated and under which the Ohio Rules became effective and why some activities of the Boiler Code Committee had made problems for them. He presented the views of the Board on the following subjects:

(1) Objection to the multiplicity of interpretations and revisions, although at the same time it did not desire to hinder progress. Interpretations that changed the meaning of a paragraph should be handled by revisions and administrative matters should be referred to the Code states or the National Board.

To this objection the Committee members pointed out that for several years the Committee had been cancelling interpretations which had been covered by code alterations so that the existing or active interpretations would be reduced to 50 or less after pending revisions had been made. The indications at that time were that the yearly number of new interpretations would not exceed 25. The Conference Committee had always had an opportunity to review and comment on revisions and interpretations.

(2) The incorrect use of the word "maximum" in certain places of the Code was objected to. The Committee members assured the Board that if there were inconsistencies they would be corrected although the word "maximum" had a definite significance where properly used.

(3) The Board suggested a careful study of complicated formulas for simplifications or the presentation of the results of their use in tables. They mentioned the formula of Par. P-212 (*b*) as one not applicable by the ordinary inspector. It was of little value, they thought, to the fabricator as it enabled him to reduce the thickness of the wrapper sheet possibly $^1/_{32}$ in. from that of the barrel sheet.

(4) To the objection to the application of Par. P-207 the Committee was fortunately able to report that a survey had just been made which disclosed that this paragraph was not being used and it already had been recommended for deletion.

(5) The Ohio Board felt that the ASME Boiler Code should be completely revised by using the most simple possible form, eliminating complicated formulas, deleting unnecessary requirements, and placing subject matter under proper heads. The Committee members agreed that complete revision was desirable and expressed the hope that the large amount of work could be accomplished.

(6) The objection to the matter of safety-valve capacities was answered by the proposed revisions of that section of the Code which had been published.

(7) The informal discussion of the proposed tube table showed the need for a new table and the care and consideration which the Boiler Code Committee was giving this problem.

The representatives of the Boiler Code Committee explained that the Committee was desirous at all times to receive constructive suggestions from various state boards and inspectors.

The representatives, in making their report to the Boiler Code Committee, expressed the belief that the conference was very helpful and resulted in a better understanding of the problems of the Ohio Board and the Committee. It had expressed its thanks to the Board for its courtesies during the session.

CONFERENCE ON SPECIFICATION S-26

A conference between the Boiler Code Committee and invited guests interested in the use of steel of specification S-26 was held on April 16, 1937. Those attending were: F. H. Andrews (Philgas, Phillips Petroleum Company), B. F. Diffenderfer and J. V. Laughlin (Downingtown Iron Works), G. P. Bard (Biggs Boiler Works), H. S. Blumberg (M. W. Kellogg Co.), J. R. Kruse (Combustion Engineering Inc.), and 20 members of the Boiler Code Committee. Letters of comment on proposed revisions had been received from the Wickes Boiler Company, the Biggs Boiler Works, and H. C. Boardman.

The first question discussed was the limitation of 0.33 per cent carbon in samples taken at any point of the plate. C. A. Adams pointed out in a letter that the limit should be 0.31 per cent and that with present manufacturing methods, there was small variation from different locations. Perry Cassidy reported that J. O. Leech had advised him that there was no objection to the sample being taken from the upper tensile-test specimen. Dr. Adams stated that his committee had differed on the requirement of 0.31 from the tensile-test specimen and 0.33 from any location. Dr. Jacobus stated that 0.28 per cent had been first suggested for samples taken at the bottom of the plate. The point was further discussed by Perry Cassidy, A. C. Weigel, and H. S. Blumberg. Mr. Blumberg pointed out that the amount of manganese of almost 1 per cent in S-26 assured added strength and that the carbon content should be not less than 0.31 per cent.

The next question discussed was the reduction in plate thickness for shells and heads from $1^1/_2$ in. to $1^1/_4$ in. for Par. U-69 vessels. Mr. Boardman pointed out that this requirement would permit the construction of an unfired pressure vessel with a one-piece head with a thickness greater than $1^1/_4$ in. if the flange were thinned down to $1^1/_4$ in. or less at the joint. This statement appeared to eliminate some questions in the minds of the manufacturers' representatives as all expressed approval of this proposed revision. The written comments from the Biggs Boiler Works and from F. G. Sherbondy, however, criticised this reduction. Mr. Weigel pointed out that this reduction in thickness in Par. U-69 as well as the revision in Par. U-76(*b*) on stress relieving would reduce somewhat the stress-relieving requirements for the thinner vessels. Dr. Jacobus pointed out that these changes were in the direction of liberalizing the requirements from the standpoint of the manufacturer without impairing the safety of the vessel.

The Wickes Boiler Company objected to the reduction of the requirements of stress relieving in Par. (U-76*b*) as their experience had shown the desirability of stress relieving because it gave additional ductility and reduced corrosion of welded joints. J. W. Wilson stated that in marine service practically all welded vessels were stress relieved.

Dr. Adams reported that quantitative knowledge of S-26 material was somewhat vague and a research on the "carbon-manganese ratio" was being planned. Messrs. Andrews and Diffenderfer expressed approval and Mr. Bard believed the revisions were satisfactory until more information was available.

A suggested revision of Par. U-13(*c*) regarding the location of the sampling was presented by Mr. Cassidy.

After the discussions, the revisions of Pars. U-13(*c*), U-69, and U-76(*b*) were approved by the Committee.

WELDING

During the years 1936-1937 the Subcommittee on Welding considered many cases referred to it but always in co-operation with the AWS Conference Committee, and at times with the directors of AWS.

On Jan. 17, 1936, the Special Committee on X-Ray Requirements reported that as a result of the adverse criticism of the master sets of radiographs indicating the maximum permissible porosity a conference had been held on Dec. 20, 1935, at which a number of users of master sets were present, particularly representatives of the petroleum industry, as well as the members of the Special Committee on X-Ray Requirements, the Joint API-ASME Committee on Unfired Pressure Vessels, the Class One Welding Association, and the API Subcommittee on Unfired Pressure Vessels. The meeting agreed: (*a*) That from

the master sets, a new set of films should be selected; (*b*) that the Special Committee on X-Ray Requirements which made the original selections should consider the inclusion or addition of consumers' interests so as to balance the manufacturing interests; (*c*) that the enlarged committee should consider the qualities of negatives for different thicknesses of welds; (*d*) that they recommend to the Boiler Code Committee that its Special Committee on X-Ray Requirements be discharged and that it appoint a joint committee with the API-ASME Committee on Unfired Pressure Vessels on these x-ray problems; and (*e*) that the Boiler Code Committee be requested to appoint six members to the new committee and that the API-ASME Committee appoint six members, the twelve being divided into four consumers, four manufacturers, and four neutrals. The former Special Committee had consisted of four manufacturers, one neutral, two manufacturers of x-ray apparatus, and Dr. Adams.

The Boiler Code Committee adopted the suggestions and appointed as the ASME group, C. A. Adams, chairman, and W. D. Halsey as neutrals, and J. C. Hodge, A. Kidd, C. W. Wheatley, and A. J. Moses as the four manufacturers. On Feb. 28, 1936, it was announced that the API-ASME Committee had designated G. C. Dick (Shell Petroleum Corporation), F. C. Fyke (Standard Oil Development Company), T. D. Radcliff (Standard Oil Company of California), and T. D. Tifft (Sinclair Refining Company) as the four representatives of consumers and Chas. W. Briggs (Naval Research Laboratory) and H. H. Lester (Watertown Arsenal) as the other two neutrals.

This committee of twelve was a special committee of the Boiler Code Committee, reporting to it, but individual members were to report to their parent committees. The name was changed to Special Committee on Radiograph Examination of Welded Joints.

X-RAY EXAMINATION

On March 12, 1937, the Special Committee on Radiograph Examination of Welded Joints reported that in June, 1936, it had approved the grinding, chipping and grinding, or suitable machining of the inside and outside of weld reinforcement of welds to be radiographed so as to remove all irregularities and leave a weld that would merge smoothly into the plate, and that the crown should not be greater than $^1/_{16}$ in. This should be used in Pars. P-102(*i*) and U-62(*i*), as in both of these paragraphs there was a provision for a new and improved penetrameter to be used when this smoothing was followed.

As apparatus had been developed to x-ray 5-in. and $5^3/_8$-in. plate satisfactorily, it recommended that the present limit of $4^1/_4$ in. be raised to $5^1/_4$ in. On the approval of this limit and the use of Buckey type grid, the resulting changes were authorized in parts of Pars. P-102(*i*) and U-68(*i*) covering the procedure for welds in plates thicker than $5^1/_4$ in., the preparation of the welds for x-rays, and the use of a new form of penetrameter and Figs. P-4 and U-12.

On April 16, 1937, Dr. C. A. Adams reported that the Special Committee on Radiographic Examination had given consideration (at its meeting in October, 1936) to the selection of a new standard set of radiographic films, especially to the set of five used by the U. S. Navy. The Committee agreed that No. 3 film should be that showing the maximum porosity for API-ASME Code, while No. 4 would apply to the ASME Code. Mr. Halsey voted against this more stringent requirement for the ASME Code because of the added cost in manufacture.

It was further reported that the new penetrameter which was being developed would give more comprehensive information and that a proposed standard test block could be used as a check on technique, although more comprehensive than the penetrameter for regular production. Dr. Adams discussed the reliability of welds meeting the porosity shown by different films. To have uniformity between API-ASME Code and the ASME Code, the Committee voted to use No. 3 as the maximum porosity for welds by the ASME Code.

WELDING PROCEDURE AND TESTING WELDING OPERATORS

The omission of the full-section tension test specimen of a welded joint was referred to the Subcommittee on Welding and the AWS Conference Committee in April, 1935, and on Jan. 17, 1936, a number of sections of Par. U-69(*c*) were omitted on their favorable report as well as changes in other paragraphs. A letter was presented (Nov. 20, 1936) from A. E. Gibson, president of the American Welding Society, transmitting a copy of its tentative Rules for the Qualification of Welding Processes and Testing Welding Operators for consideration in revisions of the Code. These were arranged to differentiate between the qualification of processes testing and that of testing welding operators resulting in a simplification of the work of qualifying operators. First the procedure of welding was fixed and then operators had to demonstrate ability to use the procedure. These rules were referred to the Subcommittee on Welding to determine what part of the rules should be incorporated in the Code revisions.

On March 12, 1937, the Subcommittee on Welding reported seven pages of revisions to Pars. U-69 and U-70 and to Pars. UA-30 to UA-46 using the suggested rules of AWS. Under these rules a shop had a proposed definite procedure for welding; required specimens and their tests to prove their worth; and the welding operators to be qualified by the results of the tests and examination of their work.

These rules were altered at the meeting of April 16, 1937, and the completed changes appeared in the 1937 Edition of Section VIII of the Code.

CALORIZED TUBES

The subject of the welding carbon steel ends on calorized tubes had been referred to the Subcommittee on Welding and as there were no rules covering such welding in the Code and as it was believed that this was a case of safe ending old tubes, the matter was submitted to the National Board of Boiler and Pressure Vessel Inspectors on May 27, 1936. It was later shown that this question was intended to apply to new tubes so that it was then referred to a special committee. On Nov. 20, 1936, the Boiler Code Committee decided that it was not in position to make rules regarding this procedure and suggested the practice be tried on an experimental installation with the approval of the proper inspection jurisdiction. A report from the Oklahoma Gas and Electric Company with test data on such welds was considered also on Nov. 20, 1936. This showed poor bend tests and a tendency toward grain growth at the welds. Although some members of the Special Committee indicated that dependable welds could be made, the report was received as a progress report and no further action was taken.

SPECIAL STEELS

On Nov. 16, 1936, in Case No. 834, the Boiler Code Committee permitted the use of stabilized austenitic chrome-nickel steel conforming to grade 4 of ASTM Specification A 167–35T for an unfired pressure vessel with columbium ten times the carbon but not over one per cent, or titanium six times the carbon, but not over 0.60 per cent for stabilizing. The reply also included the rules for welding and stress relieving. In Case No. 836 the Committee permitted the use of a steel of ASTM Specification A 167–35T, grade 6, with 2 to 4 per cent molybdenum.

Such actions had been taken a number of times under the paragraphs which permitted the use of new available materials, the specifications for which often became parts of Section II at some later date.

ACTIONS RELATING TO WELDING

On March 12, 1937, the Boiler Code Committee approved omission of the radiograph of the final circumferential seams of Par. U-68 vessels of inside diameters of 24 in and under, provided the radiographs of the longitudinal joint had been made by properly qualified welding operators and met requirements without cutting out or welding repairs, and also provided the work on the first circumferential joint had been made by such operators. This was approved by AWS Conference Committee.

H. C. Boardman suggested on March 12, 1937, that in place of the requirement of tests of welding operators every six months for U-69 vessels, the qualification be established by a test weld made with each vessel of the same thickness as the shell with same procedure and same groove as the shell by an operator who had been properly qualified. This was believed to be difficult to apply, and further consideration was voted. On June 25, 1937, the Committee gave as its opinion (Case No. 841) that a welding operator regularly qualified and engaged in welding U-68 vessels was qualified thereby to weld U-69 and U-70 vessels provided the same position was employed as that for which the operator had been qualified. Similarly, welding operators qualified for welding U-69 pressure vessels were qualified to weld U-70 vessels. All such qualifications were not to be effective for more than six months except as noted in Pars. U-69(*a*) and U-70(*a*), respectively.

SUBCOMMITTEE TO REVISE SECTION VIII

Since the adoption of the API-ASME Code for Unfired Pressure Vessels in 1934 there had been a desire on the part of some of the Committee to revise Section VIII so as to have it closer to, if not the same as, that Code and to reduce the two Codes to one. For this purpose a special committee was appointed as noted in the foregoing chapter. On June 26, 1936 a statement by the Committee was presented for publication in MECHANICAL ENGINEERING. This proposed a revision with two parts. Part I would bring Section VIII into the same arrangement as that of the API-ASME Code, the working stresses to be less than those of Part II. Part II would include such mandatory inspection as would justify a factor of safety of four so as to make this section identical with the API-ASME Code. The Committee requested suggestions and criticisms.

In Part I of this proposal the reference to Pars. U-68 and U-69 would be eliminated and Par. U-70 would be retained, but with limitation to those vessels which would be x-rayed and stress-relieved or only stress-relieved. Certain modified paragraphs from the API-ASME Code were suggested for this part for application to the classes of vessels *A*, *B*, and *C*. This report was revised Sept. 18, 1936, for MECHANICAL ENGINEERING for October.

TEST OF BOILER DRUM WITH HOLES PIERCING WELDS

On Oct. 28, 1937, a communication dated Sept. 27, 1937, from Dr. D. S. Jacobus reported tests by Prof. H. F. Moore on a welded drum with radial tube holes located in various positions relative to the weld. He asked, on behalf of the Babcock & Wilcox Company, if on the basis of the data submitted, it would be permissible to modify the requirements of Pars. P-105(*c*) and U-74 to permit the drilling tube holes $\frac{1}{8}$ in. from the edge of a weld made in accordance with the requirements of Pars. P-101 to P-109, inclusive, or Par. U-68.

The repeated-stress test, similar in method to that reported in Chapter VI was made on a shell with welds of greater porosity than the first standard required by the Boiler Code and much greater than the standard of 1937. The report gave the spacing of the tubes with their positions relative to the weld and the method of closing them with expanded nipples. The drum had been subjected to 800,000 cycles of hydrostatic pressure which developed pressures to $1\frac{1}{2}$ times the hoop stress due to working pressure with welded-joint efficiency of 100 per cent and without cracks being found by external and internal examination at the end of the tests.

It was reported that a more severe test on a vessel with the tube holes in the weld of less porosity had been made and the vessel had ruptured at 190,000 repetitions of pressure to $1\frac{1}{2}$ times the working pressure. The steel of Specification S-27 had a minimum tensile strength of 70,000 psi, giving 21,000 psi as the maximum hoop stress under the repeated load.

H. Le Roy Whitney reported extended tests made by the Class One Welding Association giving complete data on strength of weld metal, its impact value, and the ductility of the heat-affected zone and the base metal. These tests indicated that the metal of the heat-affected zone was infinitely superior in strength, ductility, and homogeneity to the base metal. He saw no reason why the Code should have any prohibition against drilling holes across or in welded joints. A. C. Weigel stated that when holes were drilled across or near welded joints for tubes there was a variation of hardness, particularly in the base metal, so that the holes were out of round. He believed that the holes should be drilled to at least $\frac{1}{8}$ in. from the heat-affected zone. James Partington pointed out that the drilling of the weld of 90 per cent efficiency would demand a thicker plate because the ligament efficiency would be less than that for holes in the plate where this 90 per cent did not enter into the computation. Others discussed different features, but later at this meeting the Boiler Code Committee voted that it was permissible to allow unreinforced holes to be machine-cut through plates with welds made in accordance with Pars. P-101 to P 109, but that these should not be placed closer than $\frac{1}{4}$ in. from the edge of the fused metal.

As the Boiler Code Committee had always ruled that only the base metal and none of the clad metal should be used in determining the strength of vessels clad with a metal of desired properties, frequent inquiries, resulting in cases or communications, had been made. On Nov. 20, 1936, James Partington, chairman of the Subcommittee on Welding, stated that in place of considering one type, nickel cladding, as in Case No. 828, the case should be formulated to cover all kinds of cladding material. Rules should be formulated to cover the removal of the cladding near the joint before welding, the welding to be done in a way to avoid any contamination of the cladding material, and the cladding should be replaced over the welding to restore complete protection against corrosion. Hence the Boiler Code Committee appointed a special committee to consider the subject of clad vessels consisting of S. K. Varnes, chairman, E. C. Chapman, H. J. French, J. C. Hodge, R. K. Hopkins, and others. H. J. French could not serve and F. P. Huston was appointed. T. McLean Jasper and A. B. Kinzel were added in December, 1936, and Dr. W. G. Theisinger in April, 1937.

On April 16, 1937, the chairman, S. K. Varnes, reported that he had heard from all members of the special committee and that the rules applied at least to nickel-clad, stainless-steel, and chromium-clad metals. Requests would be made of manufacturers for test data to show effectiveness of bond between layers and twist and buckling tests should be made with cladding on the inside when machined for the gripped section. Appropriate tests would be prescribed to care for migration of metals, ductility, and impact resistance. Reverse bend tests and impact tests would be covered and it might be advisable to include chemical and microscopic examination. X-ray examination might be necessary as well as fatigue tests.

(*Chapter VIII to be continued*)

CLEANING FLUIDS *by Means of* CERAMIC FILTER MEDIA

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HISTORICAL BACKGROUND

IN one of his many experiments in defense against the theory of spontaneous generation in the 1870's, it occurred to Louis Pasteur and one of his associates, Jules François Joubert, that water from deep wells, which had undergone slow filtration in sandy soil, was often essentially or even completely free from germs (1).[1] This observation soon led Charles Edouard Chamberlain, another associate of Louis Pasteur, to devise the original Chamberlain-Pasteur bacteriological filter which played such a vital part in the science of bacteriology, biology, and medicine during the time of Pasteur and for many years to follow. Such is the conception, development, and initial application of an important filter element, utilizing a basic ceramic filter medium—porous porcelain.

No major improvements were incorporated in this filter element or the materials from which it was produced for almost 60 years. In 1938 E. Blaha developed manufacturing techniques to the extent that porous porcelain is now available with controlled pore size, and capable of much greater flow rates. Later, through Blaha's efforts, additional grades based on the size of the maximum opening were presented and the basic elements were produced in a variety of shapes and sizes which enabled utilization on production operations. This basically improved material is designated as microporous porcelain.

WHAT IS MICROPOROUS PORCELAIN?

Microporous porcelain is a hard, rigid, porous body consisting essentially of the oxides of silicon, aluminum, potassium, and sodium, with traces of the oxides of iron, calcium, and magnesium. It is basically a fine-grain material, having an exceptionally smooth surface, and is produced so that individual particles are permanently bonded to eliminate the presence of any loose material. Through intricate blending, casting, and firing operations a uniform porous structure is presented with complete control over the size of the maximum opening.

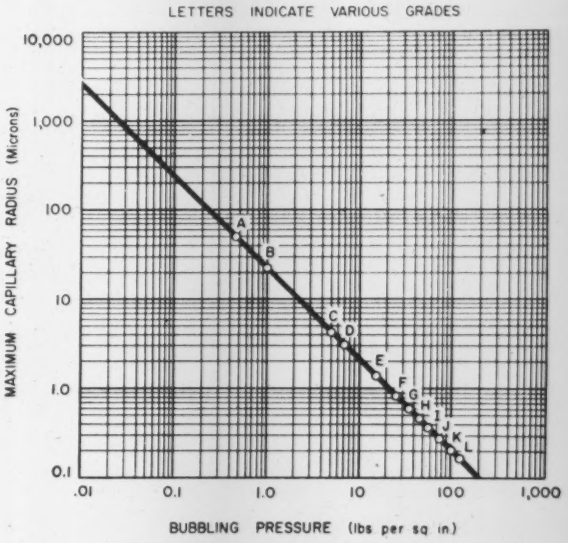

FIG. 1 RELATIONSHIP BETWEEN BUBBLING PRESSURE AND MAXIMUM CAPILLARY RADIUS OF STANDARD GRADES OF MICROPOROUS PORCELAIN

Physical and Chemical Properties. The principal physical properties of microporous porcelain are outlined in Table 1. The maximum pore radius is determined by the "bubble-pressure method" (2) based on an equation developed by Herbert Freundlich (3). This procedure consists essentially of saturating the membrane with distilled water, slowly applying air pressure to one side of the element properly assembled in a holder and immersed under water, and noting at what pressure the first dynamic air bubble appears from the surface of the membrane. The relationship between this "bubbling pressure" and the maximum capillary radius for each grade of microporous porcelain is indicated in Fig. 1. This graph also can be utilized to determine the maximum capillary radius of any naturally hydrophilic membrane using the bubbling-pressure methods.

TABLE 1 PHYSICAL PROPERTIES OF MICROPOROUS PORCELAIN

(Values based on actual averages)

Physical properties	Grades of microporous porcelain							
	A	B	C	D	E	F	G	H
Maximum capillary radius, microns (10^{-4} cm)	50	20	4.4	3.0	1.4	0.85	0.60	0.45
Average capillary radius, microns (10^{-4} cm)	25	10	2.2	1.5	0.70	0.42	0.30	0.22
Bubbling pressure, psig	0.45	1.0	5.0	7.0	15.0	25	35	45
Number[a] capillaries, per sq in. of average area	0.09×10^6	0.53×10^6	28.0×10^6	64×10^6	300×10^6	800×10^6	1500×10^6	1800×10^6
Porosity, vol. of capillaries/total volume, per cent	27	40	71	65	66	59	57	58

[a] Calculated from average capillary radius and highest porosity figure.

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Process Industries Division and presented at the Annual Meeting, New York, N. Y., November 30-December 5, 1952, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Microporous porcelain possesses a high degree of heat resistance, capable of being subjected to repeated heating and cooling cycles. Because of its high initial firing temperature, safe operation is available at temperatures up to 2400 F. The coefficient of thermal expansion is approximately 4.7×10^{-6} per deg C (room temperature to 1000 C).

In spite of the fineness of the openings present in microporous porcelain, practical flow rates are available—as indicated in Table 2 listing the initial flow rates of various fluids through the standard grades.

TABLE 2 FLOW RATES OF FLUID THROUGH MICROPOROUS PORCELAIN

(Values based on actual averages)

Fluid, per hr, per sq ft of area per lb pressure drop for 1/8 in. thickness	Grade of microporous porcelain							
	A	B	C	D	E	F	G	H
Air, cu ft	14000	6000	900	450	76	32	16	9
Water, gal	800	270	50	22	5	2.0	1.2	0.7
Gasoline, gal	1120	500	51	43	7	3	1.6	0.9
Kerosene, gal	400	175	18	16	3	1.2	0.6	0.4

Microporous porcelain is chemically inert, being resistant to all solutions which do not attack silica.

FIG. 2 GROUP OF VARIOUS MICROPOROUS-PORCELAIN FILTER ELEMENTS

Available Shapes and Sizes. The variety of shapes and sizes in which microporous porcelain is available is indicated in Fig. 2. The group of laboratory filter ware includes the filter crucibles, micro and semimicro filter ware and filter funnels utilized in quantitative and qualitative analytical procedures. The microporous-porcelain disk is permanently glazed into a high-temperature glazed-porcelain body, forming units having matched thermal-expansion rates capable of repeated ignitions without loss of weight.

Basic elements for production filtration operations are normally supplied in the form of disks, plates, and cylinders. Disks up to, approximately, 6 in. diam $\times$ 1/2 in. thick, plates up to 12 in. square, and cylinders up to 6 in. diam $\times$ 24 in. long are available.

A variety of cementing, clamping, flanging, and sealing arrangements can be utilized to incorporate these basic elements into practically designed encasing equipment.

Cleaning Procedures. Microporous porcelain is cleaned effectively by acid treatments or ignition depending on the types of contaminations. Repeated cleanings do not alter the original filtration characteristics of microporous porcelain.

MECHANICS OF FILTRATION THROUGH MICROPOROUS PORCELAIN

Filtration through microporous porcelain is accomplished through a combination of three phenomena—adsorption, particle retention, and electrical charge. Of the three, particle retention is considered to be the most important.

Being granular rather than fibrous, microporous porcelain is independent of bulk, or fiber matting for filtration efficiency. Although adsorption is a contributing factor to the effectiveness of any filter medium with the exception of screens, the comparatively thin wall of the microporous-porcelain filter element lessens the importance of this phenomenon in filtration. This condition is utilized to an advantage in the filtration of expensive medicinal preparations where excessive total adsorption would present a considerable loss of material, or, in the processing of complex biologicals which can be altered through excessive selective adsorption.

Tests have indicated that both particle retention and adsorption occur primarily within the first few thousandths of an inch of the exterior wall of the filter element, the majority of solid particles being retained on the surface. This condition permits a higher average flow rate than that which would be available if the majority of particles were trapped within the interior pores of the element. To effect a greater average flow rate it is recommended that filter elements having maximum pore openings smaller than the average size of the majority of the interfering particles be utilized.

Uniform distribution of pores permits equal filtration rates throughout the entire element area thereby eliminating "dead areas" which set up static flow conditions in these areas.

The over-all effects of electrical charges on filtration efficiencies through fine porous ceramic filter media are rather difficult to evaluate properly. Results obtained will be influenced by variations in the porosity characteristics of the filter element, the pH of the liquid being processed, the type and intensity of the charge of the particles entrained in the liquid, the electrical conductivity of the liquid, the relationship between the charge of the particles entrained in the liquid, and the charges on the walls of the filter, the surface tension of the liquid, period of filtration, pressure at which filtration occurs, and many other conditions. However, it is sufficient to state that the walls of the capillary pores of a fine porous ceramic filter medium are electrically charged and will retain particles carrying an opposite charge (4). Investigators have indicated that the walls of the capillary pores of porous porcelain filters carry a negative charge and under ideal conditions will retain particles carrying a positive charge (5).

The effects of electrical charges on critical filtrations as carried out in biology, bacteriology, and virology are of much greater importance than any they might have on general process filtrations, since this group is dealing with much finer particles creating considerably greater interference. However, in view of the more critical filtration operations presently being carried out by the process industries, the effects of this phenomenon on filtration efficiency no doubt will receive greater attention.

Because of the variable influences that the phenomena of adsorption, particle retention, and electrical charges exert on filtration efficiencies, it is rather difficult to state a definite relationship between the size of the maximum opening present in a filter element and the size of the particles retained. For example, in bacteriological filtrations several types of organisms of much greater size than the maximum opening of the microporous-porcelain element will readily pass through because of their extreme flexibility. Conversely, on the polishing of solutions for molecular-weight determinations through light scattering techniques, investigators have indicated the complete removal of all particles down to 1 millimicron by utilizing a grade H microporous-porcelain element (maximum pore diameter 0.45 micron). However, numerous observations in the use of the coarser grades of microporous porcelain (grades A to E)

have indicated generally that the size of the smallest particle retained is approximately one third the size of the maximum opening present in the filter element. In the case of the finer grades (grades F to H) the size of the smallest particle retained is approximately one fourth the size of the maximum opening present. This general relationship demands that the grades of filter elements be designated on the basis of the maximum opening rather than on the basis of other general characteristics, such as the size of the average opening and initial flow rate, which have little or no bearing on filtration efficiencies. Specifying grades on basis of the maximum opening enables quick and convenient selection of the proper grades in relation to the degree of filtration to be accomplished.

FILTRATION APPLICATIONS

The clarification, polishing, and "cold sterilization" of injectable preparations, as processed by the pharmaceutical industry, demand a fine porous medium which is chemically inert, has a minimum adsorptive factor, and is capable of practical flow rates. In particular, cold sterilization specifications are quite stringent since, in addition to removal of extremely fine particles, all bacteria must be retained. This is the final processing operation prior to injection into a human body.

The fragility of pharmaceutical and biological preparations presents many problems in the selection of the proper grade of filter elements, the design of encasing equipment, and production systems. For example, all vitamin preparations are extremely sensitive to metallic contacts and in particular to the presence of any free metallic salts in the filter elements. The therapeutic value of suspended protein solutions is destroyed by excessive total or selective adsorption. Parenteral preparations can be rendered unsterile by lack of control over the maximum opening in the filter elements. Nonuniform porous structure in a filter element will cause accelerated coagulation of blood plasma. Yet, these preparations and many hundreds of others must be produced safely and economically on a production basis.

The entire filtration system must be designed for operation under aseptic conditions and assembled in such a manner as to allow for convenient inspection and cleaning. The metal surfaces of the encasing equipment are generally highly polished and all crevices and sharp corners eliminated to reduce the possibility of trapping contaminations. The filter unit must be constructed to enable repeated heat sterilizations by autoclaving at steam pressures of 15 psi for a minimum of half an hour.

Concerning the relationship between the filtration operations to be accomplished and the available grades of microporous porcelain: grades A, B, and C are generally utilized for clarification, depending on the degree of clarity required. Polishing is generally accomplished through the use of grade D. Cold sterilization requires the use of grades E, F, and G depending on the degree of contamination, volume to be processed, and the safety factor required.

Fig. 3 illustrates a complete system for the cold sterilization of injectable preparations on a production basis. This system consists essentially of a pressure vessel and a stainless-steel-encased microporous-porcelain filter element in grade F which is connected directly to sterile receiving bottles. Flow is accomplished by carbon dioxide or nitrogen pressure, eliminating the use of a mechanical pump as a possible source of contamination. Batch capacity of this system is 30 gal at the rate of 12 gph at a pressure of 15 psi. Similar systems are in operation having batch capacities of 300 gal at the rate of 120 gph at a pressure of 25 psi.

A number of the well-known antibiotics are cold-sterilized on a production basis through the stainless-steel-encased multiple-element pressure unit, illustrated in Fig. 4. Available with 7, 13, or 19 elements (2 in. diam × 10 in. long) the units allow rapid processing of these expensive drugs. For example, a 19-element unit equipped with grade F filter elements has a capacity of approximately 500 gph at 30 psi. Similar units for the polishing of hospital liquids and plasma diluents prior to heat sterilization and for the clarification of oral solutions and topical applications have capacities up to approximately 7500 gph at pressures up to 30 psi.

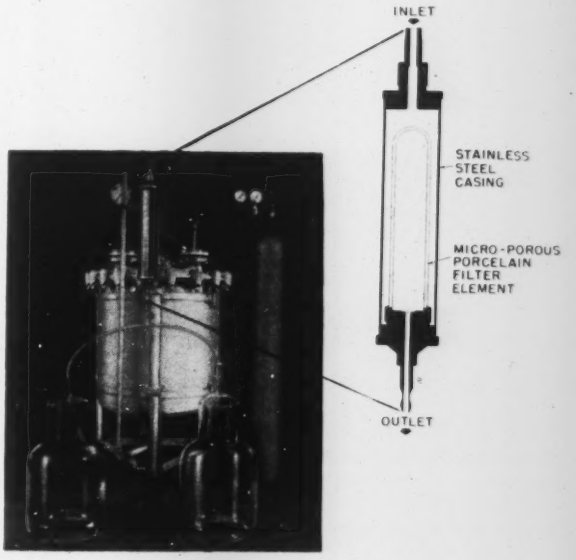

FIG. 3 COLD-STERILIZATION SYSTEM UTILIZING A STAINLESS-STEEL-ENCASED MICROPOROUS PORCELAIN-FILTER ELEMENT

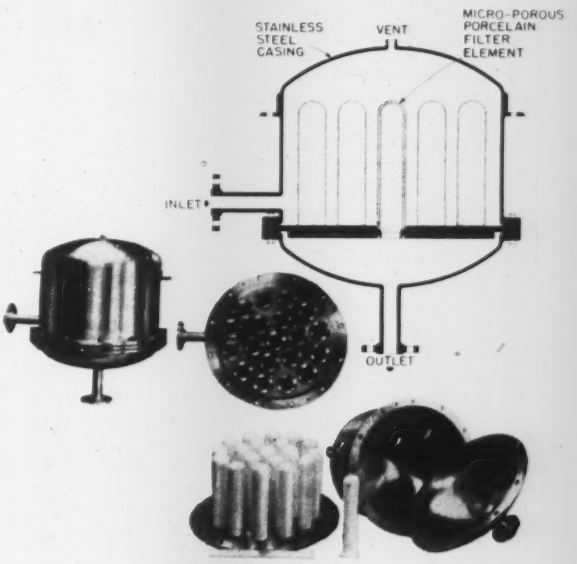

FIG. 4 STAINLESS-STEEL-ENCASED MULTIPLE-ELEMENT PRESSURE FILTER

Other process industries utilize microporous-porcelain elements for a variety of critical filtration operations. For example, in the chemical industry, analytical grade reagents such as nitric acid, hydrochloric acid, sulphuric acid, and a number of others are clarified in units illustrated in Fig. 5. The polishing of concentrated hydrogen peroxide for military use is accomplished by the use of similar units employing grade F filter elements.

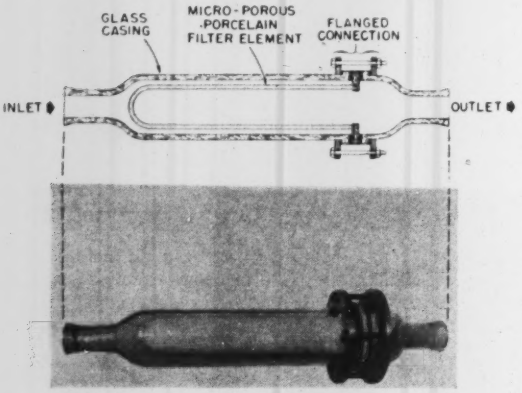

FIG. 5 IN-LINE GLASS-ENCASED SINGLE-ELEMENT PRESSURE FILTER

One of the principal difficulties in the plastics industry is the preparation of transparent and translucent plastics completely free of particles and fibers, which interfere greatly with the brilliancy of the finished product. Single and multiple-element units incorporating grades B, C, D, and E are utilized for the polishing of plastic intermediates at rates up to 4000 gph prior to formation of sheets, rods, and finished forms. This conditioning results in the presentation of plastics having much greater transparency owing to the absence of any particle or fiber interference.

The clarity of the picture on television can be spoiled by the presence of annoying dark spots and streaks on the screen; therefore the tube must be prepared carefully before the screen is put on, and the screen coating must be completely free of any interfering particles. Many picture-tube manufacturers depend on filter units incorporating grades D and E for the polishing of deionized and distilled water for the washing and rinsing of the tubes prior to screening operations. Multiple-element units having capacities of 10,000 gph of distilled and deionized water are in operation. Multiple installation of single-element units incorporating grade D elements condition the phosphate screen coating.

The meticulous procedures necessary in the manufacturing of instrument aircraft bearings can be counteracted by the presence of fine particles in the bearing assemblies, causing inaccurate measurements. Manufacturers employ single-element units incorporating grade F elements for the microfiltration of solvents used for the final washing of the bearing assemblies. The solvents are removed from the assemblies by compressed air, conditioned through the same-type units. This procedure has resulted in marked improvements in the accuracy of the instruments.

MECHANICS OF FLUID SEPARATION THROUGH MICROPOROUS PORCELAIN

The process of cleaning fluids through microporous porcelain is not limited to the removal of interfering solids from liquids and gases but includes also the removal of an interfering liquid from a liquid phase, gas from a liquid, and liquid from a gas. By utilizing basic principles of capillary physics and surface chemistry complete phase separation of immiscible fluids by means of surface tension or interfacial tension have been accomplished through various types of porous media.

Any porous medium is pervious to any fluid under certain conditions provided the size of the capillaries through the medium are larger than the molecular size of the fluid; conversely, any porous medium is impervious to any fluid under certain other conditions. The conditions which determine whether a porous medium is pervious or impervious to a fluid depend primarily on the surface or interfacial tension value of the fluid, the size of the maximum capillary in the medium, the degree of wetting, nonwetting, or preferential wetting of the medium by the fluid, and the pressure drop of the fluid system across the medium. Liquid-liquid separations have been achieved on the basis of this theory (6); however, this discussion will be limited to its application on liquid-gas separations through properly conditioned microporous-porcelain elements.

In discussing the phenomenon of liquid-gas separation through porous media it is necessary to consider that the interface between the liquid and the gas has strength and will resist rupture. If this interface is supported across the capillaries of a porous medium, its resistance to rupture will increase as the size of the maximum opening is decreased and as the surface tension between the liquid and gas is increased.

In selecting a porous medium to effect a complete phase liquid-gas separation it is necessary that the medium be uniformly porous with the maximum capillary opening fine enough to support the interface against rupture by the pressure system. In addition, the surface of the porous medium not only must be completely wetted by the fluid to be discharged through its capillaries, but must be preferentially wetted by that fluid so that the other fluid will never displace the first.

FLUID SEPARATION APPLICATIONS THROUGH MICROPOROUS PORCELAIN

The first industrial application of the phenomenon of surface-tension separation was an automatic liquid-gas separating unit, without moving parts, for the removal of water, water-

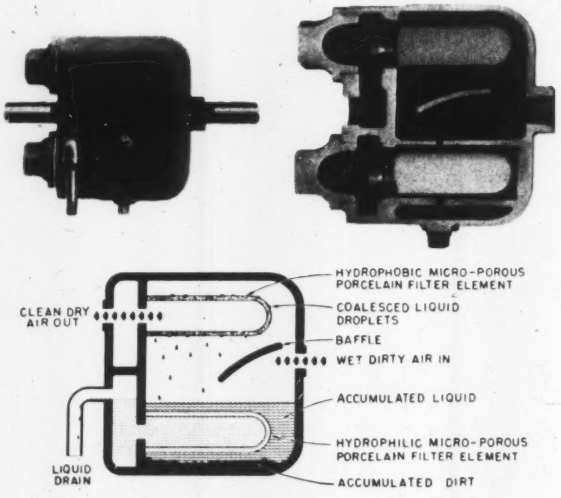

FIG. 6 DESIGN, CONSTRUCTION, AND OPERATING FEATURES OF AN AUTOMATIC LIQUID-GAS SEPARATING UNIT

oil emulsions, and dirt from compressed air or gas systems. Fig. 6 illustrates the design, construction, and operating features of a unit capable of handling 50 cfm of free air or gas at a maximum operating pressure of 125 psi. This unit utilizes two microporous-porcelain filter elements $1^1/_2$-in. diam × 8 in. long incorporated in metal assemblies. The upper, or separator filter assembly, accommodates a grade A microporous-porcelain filter element, rendered hydrophobic. The lower, or ejector assembly, employs a grade K filter element which is naturally hydrophilic.

The air or gas with entrained liquid contaminations enters the unit and passes through the upper water-repellent element which retains the free liquid phase and dirt. The accumulation of retained liquid droplets on the outer surface of the water-repellent element effects coalescing of the droplets into a liquid phase which ultimately falls to the lower section of the unit, where it is ejected automatically to the atmosphere through the hydrophilic element without loss of system pressure.

Units having capacities from 10 cfm to 2500 cfm at pressures up to 3500 psi are employed by many industries for the protection of air-operated instruments and other types of pneumatically operated mechanisms, and for the conditioning of air and gas utilized for aerations, agitations, cleaning, drying, and spraying operations.

An outstanding example of the separatory efficiencies available through the mechanics of surface-tension separation is the application of an automatic liquid-gas separator on a boiler-steam-condensing system producing good-quality distilled water. The sequence of operations of this system illustrated in Fig. 7 includes reduction of boiler steam pressure to 20 psi primary conditioning through a normal baffle-type steam separator, final conditioning through an automatic liquid-gas separator, condensing, and finally holding the condensate in a steam-jacketed vessel, effecting the release of CO_2 gas.

The distilled water produced by this system at the rate of 100 gph has a total solid content of less than 0.5 ppm, is pyrogen-free, shows a negligible residue on evaporation, and meets the requirements of water for injectable purposes (7). Hundreds of thousands of gallons of distilled water produced by this system have been utilized as a diluent for blood plasma, and in the preparation of complex biologicals. Similar systems are producing distilled water used in chemical analytical procedures and in the manufacturing of pharmaceutical products.

In addition to the conditioning of air and gases for process

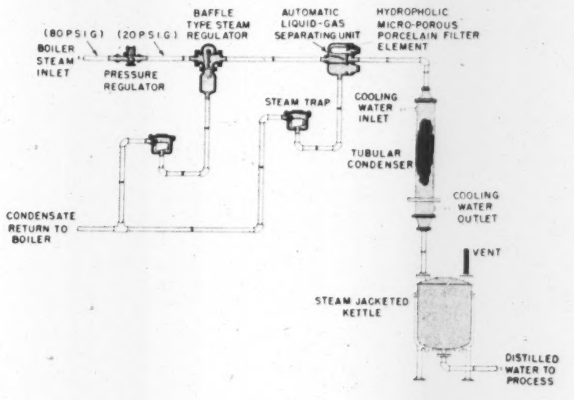

FIG. 7 STEAM SYSTEM TO PRODUCE DISTILLED WATER UTILIZING AN AUTOMATIC LIQUID-GAS SEPARATING UNIT

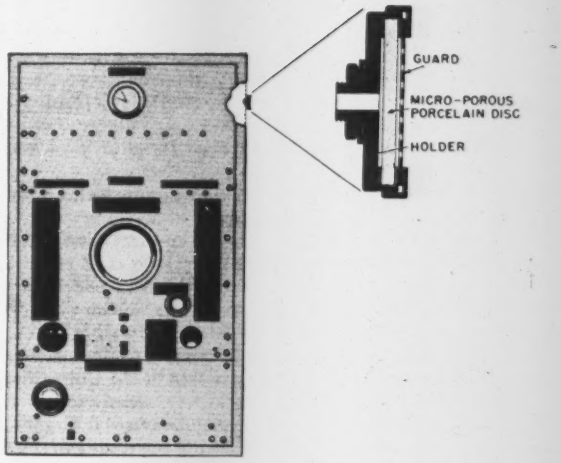

FIG. 8 AUTOMATIC BREATHING UNIT USED ON RADAR EQUIPMENT

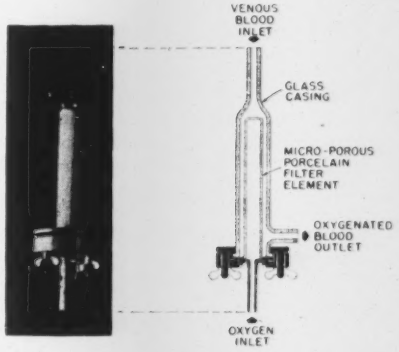

FIG. 9 "ARTIFICIAL LUNG" UTILIZING MICROPOROUS-PORCELAIN ELEMENTS FOR OXYGENATION OF BLOOD

operations, surface-tension separation is being employed to simplify the design and improve the operation of a variety of electronic and mechanical devices.

Fig. 8 illustrates the assembly and installation of a breathing unit on radar equipment for military service, permitting a free exchange of ambient air across the sealed casing, thereby eliminating the possibility of a pressure differential during variations in temperature and altitude. Simultaneously, the breathing unit prevents the passage of entrained water into the interior of the casing which would have obvious deleterious effect on the operation of the unit. Additional protection is afforded by the fact that the unit can be immersed in approximately 5 ft of water without detrimental effect. The assembly consists essentially of a grade D microporous porcelain disk approximately 3 in. diam rendered hydrophobic which is incorporated in a suitable holder attached to the side of the casing by a simple threaded connection.

Head sets on military communications systems and a number of other kindred electronic devices are equipped with breathing devices for operation under similar conditions. An interesting application includes use on storage batteries for stand-by communication service to permit escape of hydrogen during charging periods and simultaneously retain the acid within the battery. In addition, the hydrophobic-treated grade A

(Continued on page 566)

CREATIVE TECHNOLOGY

By EARL P. STEVENSON

PRESIDENT, ARTHUR D. LITTLE, INC., CAMBRIDGE, MASS.

WITHIN my lifetime there has occurred the greatest revolution in the long history of mankind. Had the prophet Habakkuk been our contemporary reincarnate, he might have been inspired to exclaim as of yore, "Behold ye among the heathen, and regard, and wonder marvelously; for I will work a work in your days, which ye will not believe, though it be told you." This might well be my theme for it summarizes the achievement of creative technology which is so largely responsible for the position of the United States today in world affairs. The quickening translation of new scientific knowledge into terms of useful devices is largely due to the invention of a system for utilizing the results of science. This is a system of teamwork among scientists, engineers, and manufacturers.

THE NEW METHODOLOGY

This new methodology has come into being in the past 25 years. It had its beginning after World War I and began to take root as an idea in the 1920's, but its growth was greatly retarded by the depression. The unprecedented technological demands of World War II provided the impetus, and the accumulated basic scientific knowledge the nourishment, for the postwar growth of the system which integrates science and engineering.

The electrical and process industries are probably the major beneficiaries of these new tactics. Within my working years the modern catalytic-cracking plant has evolved out of the Burton invention. Aviation gasoline of 100-octane rating was not the accomplishment of one man. Its development depended upon an application of fundamental knowledge in the field of organic chemistry. It is a synthetic product and not simply the result of breaking down large molecules to form smaller ones under thermal shocks. The gasoline which we use in our cars today is composed of 90 per cent "new" molecules.

The chemical industry owes much of its present glamour, and certainly most of its achievements, to research and engineering developments. Within the past 15 years the pharmaceutical industry has become the beneficiary of these same tactics. With the advent of the sulfa drugs, chemical therapy took on a new lease of life in the promise of new specifics. The antibiotics brought about another revolution in this age-old industry. Industrial research in its new and broader conception has played a most vital role in translating the laboratory disclosures of Fleming and Florey into practice.

The story of the magnetron—the tube that is the heart of radar—offers another example. As far back as the 1920's of this century, two American scientists, working on the basis of Hertz's discoveries, found that distance to an object (in their case, the height of a specific atmospheric layer) could be measured by bouncing radio waves against it. In the 1930's Sir Robert Watson-Watt, in charge of a small research group carrying out further measurement studies, suddenly noted that aircraft overhead also gave reflected signals. Quickly huddled under a British Air Ministry security blanket, a special research team developed practical installations—the British Chain of Early Warning Stations of 1939—which swayed the Battle of Britain in her favor. As one Englishman has put it, "Britain had fewer fighters than the enemy—but knew where to put them."

The great advance in radar began, however, with the cavity magnetron of Randall and Booth, the prototype of which they put together with "strings and sealing wax" in a university laboratory. Sir Henry Tizard brought a prototype to America in September, 1940, and within 6 months magnetrons were in full-scale production here. This is not merely a story of mass production, but an example of enthusiastic creative teamwork.

The development of the atomic bomb is probably the outstanding example of what can be done when creative effort is organized and focused upon a single objective—when engineers and scientists work closely together as a team to bridge the gap between scientific knowledge and engineering requirements.

Organized creative technology falls easily within the framework of our American political and social concepts and reflects our way of life in giving full play to the genius of the individual, in giving him freedom to exchange ideas with his fellows, and opportunity without artificial restraints for joining with others in creative work. European observers today note what the astute traveler, Alexis de Tocqueville, remarked about American democracy in the mid-nineteenth century—that the home training of the American child, and his subsequent school education engender in him an attitude toward community action which knows no counterpart elsewhere in the world. The American has a strong sense of individuality, but at the same time an urge to work with others in the solution of a common problem. The concept of civic responsibility has nurtured in the typical American an ability to act responsibly and creatively in a group—and without government decree as the motivating force.

ENGINEERING RESEARCH

The methodology of engineering research requires definition at the outset. I will assume for the purposes of my approach and limited traverse that this may be translated in one-syllable words into "how to get things done"—meaning to develop new techniques, processes, equipment, or products.

The term "engineering research" requires particular attention. Narrowly construed, it might mean the determination of more exact and comprehensive values and the measurement of important properties of materials in terms of specific uses. Even this restricted definition is evasive and debatable, leading as it does to the conclusion that most physical research is of this kind. It can be pointed out that since no new laws of thermodynamics, for example, have been discovered since the pioneering work of Helmholtz, Kelvin, and Gibbs, all research in the domain of thermodynamics is, a priori, engineering research. I am sure, however, that this apparently logical conclusion would not be accepted generally.

Definitions can become an ordeal in semantics. Understanding must be reached in practice and not in terms of abstract definitions. As a general proposition, I conceive the area of engineering research to be the gap between the knowledge and understanding supplied by fundamental research and that re-

Presented at the Symposium on Methodology of Engineering Research of the AAAS, St. Louis, Mo., December, 1952.

quired by the engineer in undertaking to carry out a definite assignment.

As R. E. Gibson presents the position of the scientist: "Scientific research in its most elemental form is a very private occupation which eludes all attempts to bring it under control of conventional management. The rule for the organization of pure research is, 'Don't try to organize it.' It is concerned with problems. A research problem grows in the mind of one man when what he knows from experience, intuition or doctrine conflicts with what he observes. To resolve this conflict, he must analyze the experience he has acquired or the doctrine he has inherited, and reassure himself of their consistency and sufficiency; at the same time, he must refine the processes of his observation to insure that he really knows what he is measuring and that he has observed a 'reproducible scientific fact.' This in a few words describes theoretical and experimental scientific research. When a new phenomenon is explained in terms of the system of the entities and logic which has grown gradually under repeated analysis and criticism since the time of Bacon and Newton—the system we call for short 'scientific knowledge'—we say that we understand it."[1]

In this spirit the scientist is constantly re-examining old precepts as new problems arise through the study of nature, in the writing of books, in the teaching of students, or in the practice of the useful arts. The theoretical framework of science is seldom radically modified but rather extended. Einstein's speculations did not invalidate the Newtonian laws of gravitation when these failed to comprehend certain observable phenomena. In this unorganized and highly individualized effort, the great edifice of scientific knowledge has been created.

ENGINEERING VERSUS SCIENTIFIC RESEARCH

Where basic scientific research might be said to end, engineering research begins. Increasingly the engineer and the scientist appear to operate in the same area. However, their guiding philosophy is quite different. The difference in objective is in the "think" and the "thing." An example will serve to clarify this idea.

Take the scientific problem of ortho and para hydrogen, for example, particularly as it relates to the design of a system for production and storage of liquefied hydrogen. Peculiarly enough, theoretical physicists had predicted on the basis of the quantum theory that two different kinds of hydrogen molecules should exist and should have quite different physical properties—particularly at low temperatures. This peculiarity arises from the requirement that the thermal energy of rotation of molecules is quantized or, in other words, the degree of excitation can have only certain discrete values—called energy levels. Furthermore, some molecules can have only odd energy levels and the others can have only even ones, depending on whether the two nuclei in the molecule have their spins parallel or antiparallel. This gives rise to two different kinds of hydrogen molecules, those with even energy levels and those with odd, known as ortho and para, respectively.

Chemically, the two forms are of course indistinguishable, but physically they are considerably different—different heat capacities, heats of vaporization, enthalpies, and entropies. It might be thought that normal hydrogen at room temperature would contain nearly equal amounts of the ortho and para form, but this is not the case. At room temperature and higher, normal or "equilibrium" hydrogen contains 75 per cent of the ortho form and 25 per cent of the para. As the temperature is lowered, the equilibrium composition slowly changes and is substantially 100 per cent ortho at the liquefaction temperature (20 K). If, however, ordinary hydrogen is cooled and liquefied, it retains its room-temperature composition unless a suitable catalyst is present to allow the conversion reaction to take place. In the absence of such a catalyst, normal hydrogen will liquefy with a composition of 75 per cent ortho—25 per cent para and, then, over a period of days, will convert slowly to the equilibrium state of substantially 100 per cent ortho, liberating a considerable amount of heat. The heat of conversion is actually greater than the heat of liquefaction and, consequently, freshly liquefied unconverted hydrogen evaporates away very quickly even if it is contained in a perfectly insulated vessel.

It was mentioned earlier that theoretical scientists had predicted the existence of ortho and para hydrogen before such a thing was found in nature; indeed this would seem to be one of the most convincing achievements of the quantum theory. It remained, however, for the experimentalists to verify the prediction and to explore the exact consequences of the peculiarity.

But the knowledge thus gained is not sufficient for the engineer who is interested in liquefying and storing hydrogen with minimum power expenditure and vaporization loss. In order to deal expeditiously with the conversion phenomenon, he must know the rate of conversion of ortho to para hydrogen over various catalysts for many different conditions of temperature and gas pressure. He also must assure himself of a reasonable lifetime of the catalyst under the conditions which are to prevail. What of the effects of traces of impurities such as water vapor or air? Are the physical properties of the catalyst suitable? And the heat-transfer properties? All of these and other similar questions can be answered only by engineering research. There is no theoretical structure which can be resorted to for this kind of information; nor are there handbooks to refer to in view of the fact that ortho-para conversion of hydrogen was only a scientific curiosity a scant 18 months ago. Engineering handbooks are compilations of the results of many years of engineering research. The researcher of today is writing the handbooks of tomorrow.

The designer of a new piece of equipment is fortunate indeed if he can find all he needs to know in existing handbooks. Even in the more classical areas of engineering research, such as strength of materials, heat transfer, fluid flow, and wave propagation, the information is sketchy at best. With increasing frequency as design problems become more complex, the engineer must resort to experimentation to extend the available information or test the accuracy or sufficiency of some essential bit of scientific data for use in the problem at hand.

From this discussion it may appear that engineering research is just a special example of applied research. I would take no exception to this conclusion. Where the scientist has new knowledge and understanding of natural phenomena as the primary objective, the engineer is concerned with the creation of a "thing" which in the perfection of detail can be built repetitively from commercially available materials with existing skills for use and maintenance. The automobile is one of his great monuments, as measured by these standards.

RESEARCH REPLACES THE LONE INVENTOR

Our early industrial progress depended largely upon the genius of lone inventors. These men by present-day standards were often neither scientists nor engineers. Their efforts were inspired by intuition and supported by the rare qualities of patience and persistence. Their methods were empirical—trial

[1] Address to Spring Conference, Society for Personnel Administration, May, 1951.

and error, their authority from within themselves. They were in many instances the prophets of things to come; in the nineteenth century their practical achievements laid the firm foundations of our major industries.

Leonardo da Vinci anticipated in the fifteenth century many of our modern devices—the machine gun, the aerial bomb, the tank, the helicopter, the parachute, and double hulls for ships. His thinking also evolved the first sketches of such devices as the flying spindle, the circular pulley system, the use of steam energy, a differential gear system, the jack, and the water turbine. His speculations, while reflecting a good understanding of the basic principles of mechanics, were not embodied in useful devices for several centuries.

The two Stanley brothers, one of whom I was privileged to know as a neighbor, were successful inventors in several fields. To photography they contributed the first dry plate. They might well have conceived of Kodachrome or Technicolor, but I doubt very much if they could have developed these into acceptable use. Their steam-driven automobile was a great achievement, but a turbojet would have been beyond their reach. Such statements do not, however, deny inventive genius a vital place in the changing scene as attested by the number of patent applications filed each year in the major fields of industrial research and engineering. The organized effort which has succeeded to the role of the Edisons and Westinghouses, makes good use of inventive talents. The fundamental scientist must often rely upon intuition for a first glance into the unknown and use the empirical methods of the inventor where scientific knowledge and understanding are for the moment lacking.

Engineering research has thus largely succeeded to the role of the inventor, but these talents have been absorbed and by no means discarded. The increasing complexity of engineering goals demands something more than intuition and inventive inspiration.

DEVELOPMENT OF SCIENTIFIC TOOLS

The new working alliance between the scientist and the engineer has found one of its finest and most fruitful expressions in the development of scientific tools. A trip through our postwar laboratories—industrial, government, or university—cannot fail to impress anyone with the greatly increased dependence of the investigator upon instruments. The newer instruments of physical research were previously cobbled and put together in a makeshift way. There is now very much in evidence apparatus that has been highly engineered with meticulous attention to details of design making for reliability in measurements and use by other than the most highly skilled scientist.

Fortune magazine in its December, 1952, issue, notes that there are today about 30 United States firms turning out a dozen or more laboratory mechanisms that cost over $10,000. Supplying our research laboratories with engineered scientific tools has become big business. The *Fortune* article notes four of these as being in the forefront of this new era: the x-ray diffraction equipment, the mass spectrometer, the ultracentrifuge, and the Collins helium cryostat. These instruments are playing a most important role in the new methodology of engineering research, of which they themselves are the product. These instruments are the tools of both the scientist and the engineer; they speak the language of both which is numbers.

THE SCIENTIST-ENGINEER

With this improved communication, all barriers are breaking down. Creative technology is today largely dependent for its achievements upon a hybrid, the scientist-engineer. Which talent of this dual personality comes first in title depends on whether the individual is at a given time oriented toward the "think" or the "thing."

In this new era of creative technology, the engineer has become increasingly dependent upon the scientist whose progress he no longer follows at a distance, but with the intimacy of the next-door neighbor. At the frontier of every art, the engineer is restricted by lack of understanding, data, or material. He may perceive clearly the direction in which improvements may be achieved or revolutionary developments accomplished but, before he can pioneer, the scientist must explore and achieve understanding. The scientist in turn is increasingly dependent upon the engineer for the design and construction of essential tools and for the challenge to push forward the frontiers of knowledge. This interdependence is significant for the future of both scientific discoveries and engineering progress.

Cleaning Fluids by Means of Ceramic Filter Media

(*Continued from page 563*)

microporous-porcelain element in the form of a ring incorporated with the filling cap acts as a fire check preventing the entrance of exteriorly ignited hydrogen into the battery.

The most dramatic fluid-cleaning operation, incorporating the basic elements of surface-tension separation, involves the utilization of microporous porcelain in an artificial lung for the oxygenation of blood and simultaneous release of carbon dioxide (8). Fig. 9 illustrates the general type of unit utilized by several investigators to diffuse oxygen into the blood stream of animals whose supply of oxygen has been cut off for periods exceeding $1^1/_2$ hr. The unit consists essentially of a glass-encased microporous porcelain filter element in grades D or G, depending on the degree of diffusion desired, which is rendered hydrophobic or hydrophilic depending on the type of auxiliary system utilized to remove the free oxygen from the oxygenated blood stream.

CONCLUSION

This presentation has been made in the hope that it will assist industry to evaluate the usefulness of ceramic filter media in solving some of the many problems associated with the processing of fluids and the operation of hydraulic, pneumatic, and electronic systems and devices.

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BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

J. J. Jaklitsch, Jr., *Technical Editor*

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Paper-Industry Engineers

THE manufacture of pulp and paper and other cellulose products now mainly derived from wood has become one of the major industries in the United States, their plants representing some $5 billion in assets, with over 400,000 men employed directly in the mills, and an expenditure of $650 million in annual mill wages.

These products are now of vital necessity in the world's economic life and cover an extremely diversified range. They are found in newspapers, containers, boxes, bags, towels, tissues, and the like, as well as in the nonpaper cellulose used for rayon, cellophane, plastics, and other products. The by-products from these mills also find their way into laminating materials, turpentine, tall oil, fats, adhesives, and many other uses.

To give some idea of how the engineer fits into this vast industry, the part the engineer has played and will play in the pulp and paper industry was reviewed by D. G. Moon, consulting engineer, J. E. Sirrine Company, Greenville, S. C., before a recent meeting of the ASME Greenville Section.

Mr. Moon recalled that in the earlier days the manufacture of pulp and paper was considered an art rather than a science, with operational knowledge and experience handed down from father to son. Only the crudest of measuring and testing instruments were used. It was quite an ordinary occurrence, he said, to see the pulpmaker test his liquor by feel or taste, his cooking by the manner in which his digester vibrated, or the quality of his finished pulp by holding it to the light to gage the length of the fiber.

Today most of the processes, tests, and characteristics are controlled by the use of concise instrumentation and testing apparatus. Also, the majority of the operators have had technical training or have taken advantage of some courses offered by management during their apprenticeship period.

The Chemical Engineer. At present the chemical engineer has an all-important part in relation to the control of the liquors, their analyses, the testing of pulp and paper for all of their requirements, the extraction of by-products, as well as in the carrying out of continuous research. He is also called upon to exercise control and work out methods for the recovery of chemicals from the various process liquors, as well as to supervise and control the actual manufacture in some cases of chemicals used by the plant, such as chlorine, caustic, chlorine dioxide, SO_2, neutral sulphite, and the preparation of size and colors.

The maintaining of waste effluent from the mill to a minimum also requires careful control, testing, and supervision by the chemical engineer.

Plant Engineer. The plant, maintenance, or chief engineer in many mills ranks next to the general manager due to the importance and complexities of his duties in a field where a basic and practical knowledge of civil, mechanical, electrical, power, and chemical engineering is a necessity. He and his assistants exercise control of maintenance, the supervision of equipment, and the efficiency of its operation, and are usually responsible for the development of mill expansions needed to meet the never-ending change in process requirements as new methods come into use. Mechanization of the woods operation has progressed rapidly to offset the higher cost of labor, which requires engineering studies on new equipment to facilitate the handling.

There are many processes and equipment that require the plant engineer's supervision, according to Mr. Moon. In general, however, the wood has to be brought into the mill, stored and barked, then chipped and stored, all requiring complicated conveyers.

The chips are then usually conveyed to digesters or pressure vessels for the cooking operation in conjunction with the liquors. The pulp is then blown, washed, and screened, and may also be bleached—all on intricate machinery. It is then refined and put in condition for delivery to the paper machine.

The modern paper machine is a highly specialized piece of equipment, receiving the pulp fibers highly diluted with water, removing this water, and forming a sheet on a traveling wire, pressing out part of the water mechanically and removing the balance in steam driers, calendering it, winding, and slitting for finished rolls.

The modern drives for these machines are arranged with motors and electronic controls, with interlocks capable of

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources: i.e. (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

automatic adjustment, and electric eyes for redistributing the fast-moving stock when a break occurs.

Where groundwood is used in conjunction with other pulps, grinders to take 5-ft wood may be used, with equipment governors and hydraulic control machinery connected to synchronous motors of from 4500 to 8000 hp, which are fed by automatic conveying systems. Usually the chemical process requires the careful recovery of the liquor, it being concentrated in multieffect evaporators to a point where they will sustain their own combustion for use as fuel under a steam boiler, with the chemicals recovered in the form of smelt. This latter is subsequently recausticized by adding lime, the resulting sludge being reburnt for use in a kiln.

The normal pulp and paper mill usually maintains a well-equipped machine shop, supplemented by facilities for pipe fitting, welding, woodworking, and motor rewinding—sufficient to handle all normal repairs.

Mr. Moon pointed out that the pulp and paper mills require large quantities of good-quality water, the requirements varying from 30,000 gal per ton of product in a board mill, up to 100,000 gal per ton of product in a bleach or dissolving pulp mill. If the water supply is taken from wells, softening is usually required and in many cases settling basins and sand filters have been provided for the treatment of surface water supplies.

The pulp is transported mainly in liquid form, and a normal mill may well have over 300 pumps ranging in capacity from 50 to 40,000 gpm. The majority of these pumps are designed especially for handling of corrosive liquids, as well as for pulp handled at high consistencies. Almost every classification of pipe and valves can be found in these mills.

Control instrumentation is an important and now highly developed factor requiring careful engineering supervision. A normally small mill would require at least 300 instruments.

In the integrated mills the converting plants also need considerable mechanical engineering for the design improvement and operation of the various automatic machines required to transform the paper into boxes, bags, sacks, drinking cups, and other specialties.

The Civil Engineer. Civil engineering enters into the mapping of the timberlands and other mill properties, with provision for proper drainage, fire lanes, truck roads, and docks, as well as supervision of construction.

Power and Electrical Engineers. The supervision of power generation by the engineering staff in a modern pulp and paper mill is of prime importance, Mr. Moon said. The integrated mill usually requires high-pressure boilers designed especially for the burning of waste liquor, with chemical recovery as well as other types for the burning and generation of steam from bark and those using coal, oil, or gas as fuel. The high-pressure steam delivered to turbine-generators is extracted at desired pressures for the process requirements in the mill, with the condensing stage to provide for the generation of power over and above that obtainable from process steam requirements. The chemical pulp and paper mill is usually able to generate 70 per cent or more of its power from its process steam requirements.

The electrical engineer also plays an important part. The trend has been toward higher generated voltage, such as 4160, with distribution to load centers, using air-cooled transformers, cubical-type switchgear, and air circuit breakers. Motors of 200 hp or more are usually of the synchronous type to assist in power-factor correction, and many variable-speed motor applications and electronic controls are found necessary.

Proper heating and ventilating of the process rooms is another engineering problem. The tendency today is to entirely enclose the buildings, maintaining them under a slight pressure with incoming air filtered for the removal of dirt. In addition, where corrosive vapors are prevalent the air may be taken through carbon filters.

The Sales Engineer. The sales engineer also has a large part in the development of the industry, Mr. Moon said. He is usually a specialist in some particular line relating to the equipment, materials, or processes of the company he represents. He must know his product thoroughly and be able to impart full information regarding it to the technical staffs of the mill and also be able to operate, observe, and correct his installations under actual manufacturing conditions.

The Consulting Engineer. The consulting and design engineers are responsible for the initial development and construction of the new mill project or retained for special operational studies. They must have on their staff or available to them through various departments, specialists in all of the different phases of engineering that are encountered, such as civil, chemical, water purification, structural steel and building design, architectural, steam and electrical engineering, instrumentation, piping, materials handling, and the like.

While some of the larger companies operating several mills maintain a relatively large engineering staff capable of going into the many details that arise, the consulting engineer and his specialists are frequently called in for major expansion and functional problems.

The magnitude of the requirements for a pulp and paper mill can be realized when it is considered that they vary in initial construction costs from $60,000 to $100,000 per daily ton of finished product, or approximately $12 million for a minimum economic mill, up to $50 or $60 million for a newsprint mill.

Mass Flowmeter

A MASS flowmetering instrument that measures liquid flow on a pound rather than volume basis has been developed by the Gavco Corporation, New York, N. Y., a subsidiary of General Aviation Corporation. Unlike other recent mass flowmetering devices, which generally use the Coriolis acceleration effect, the Gavco instrument distinctly separates the functions of volumetric flow measurement and density determination. This permits the instrument to be used as follows: As a volume flow-measuring device, with accuracy to $^1/_2$ per

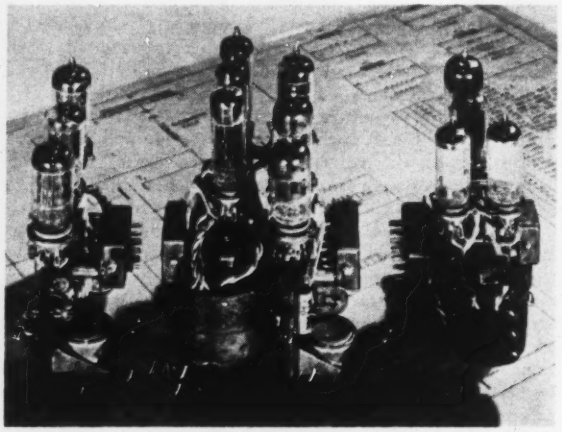


FIG. 1 ELECTRONIC UNITS OF MASS FLOWMETER

(Shown without housings are, *left* to *right*, the density compensator, the integrator, and the indicator drive. The three tubes on the left side of the integrator comprise the system's power source. Units are designed to plug into each other or into other standard equipment.)

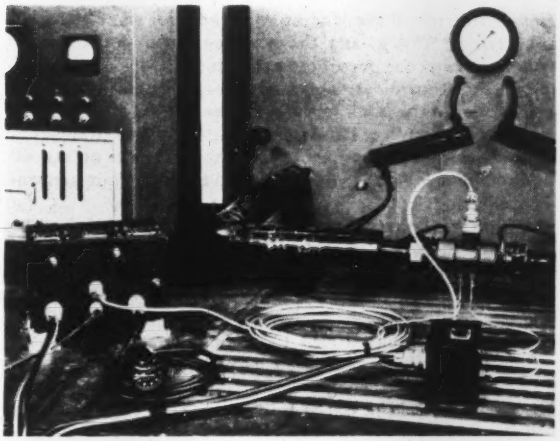


FIG. 2. TEST-BENCH HOOKUP SHOWING FOUR BASIC UNITS THAT MAKE UP THE MASS FLOWMETER

(In the foreground, *left* to *right*, are the electronic assembly, the indicator, and the density detector. Shown installed in the pipe line is the volume sensing element.)

cent; as a density measuring instrument which will detect density changes of 1 per cent; or as a mass flow instrument by integrating the two. Finally, the null-balance potentiometer-type indicator can be interchanged with standard Brown recorders when more precise laboratory readings are desired. Complete weight of the system is less than eight pounds.

The sensing unit of the mass flowmeter, using an inverted venturi, will measure the volume flow through a range of 60–1 with a pressure drop of less than $^3/_4$ psi at 20,000 lb per hr. This sensing unit is designed so that the rotor revolutions do not "generate" current as do other such devices which must use a bulky rotating magnet in the sensing element. In the Gavco flowmeter sensing unit, a permanent magnet is placed in the upper part of the housing with two soft-iron inserts going down into the rotor housing. A three-armed shaft turning in the magnetic field that passes through these soft-iron inserts breaks the flow of flux three times per revolution.

Details of what takes place in the density detector cannot be revealed at present until a clearer understanding is reached with the Services regarding the security status of the system, Gavco points out. It can be said, however, that a simple mechanical vibration principle is used and changes in density are reduced to electrical terms.

The three-unit electronic element is designed for complete versatility by using simple plug-in subassemblies. Density changes are fed electrically into the density compensator—which can simply be unplugged from the system if volume readings alone are desired. The signals from the sensing unit are fed into the integrator box and combined with the data received from the neighboring density compensator. These integrated data are in turn fed to the indicator drive unit.

Within the dial indicator, a rubber-tired gear grain is designed to be self-compensating for wear. The spring-loaded wheels ride on tapered hubs and move up the slope as they wear.

At present the system is designed to handle flows of 300 to 60,000 lb per hr at up to 1000 psi with smaller and larger capacities to follow. It has been made "fail-safe"—all foreseeable malfunctions produce zero or off-scale readings. It is explosionproof since there is no electrical contact with the measured fluid and can be made completely environmentproof by casting the electrical circuitry in resin. Totalization of rate through a number of units can be installed, or totalization of volume through a single unit.

According to Gavco engineers, applications for the unit are widespread throughout industry and aviation. Jet fuel consumption on a pound basis is the most critical need for the system at the moment although countless other uses are foreseen. The petroleum industry has needed a dependable mass-flow instrument to remove the inaccuracies caused by changes in specific gravity. Other industries affected by changes in specific gravity of liquids are the chemical industry, food and beverage industries, and the air-conditioning industry.

Plane Deceleration Chute

ANNOUNCEMENT of U. S. Air Force parachute brake research which resulted in the F-94C Starfire becoming the first production fighter-type plane equipped with a deceleration chute was made by Lockheed Aircraft Corporation, Burbank, Calif., and the Air Force's Air Research and Development Command, Baltimore, Md.

Studies show that the type of nylon chute finally adopted for the F-94C, a jet interceptor designed for air defense of the United States, provides marked economies in tires, brakes, and landing-gear maintenance, as well as enabling the 600-mph plane to land in almost half the distance that would be necessary without the extra deceleration device.

The drag parachute, designed by parachute specialists at the Air Research and Development Command's Wright Air Development Center, Dayton, Ohio, answered the need for an auxiliary means of deceleration to compensate for the F-94C's higher landing speed, which increased the wear on brake in-

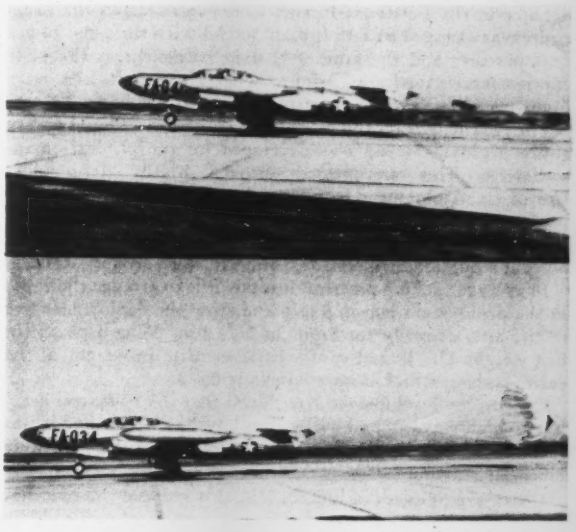


FIG. 3 SPLIT-SECOND ACTION OF THE SLOW-DOWN PARACHUTE RELEASED FROM THE TAIL OF A LOCKHEED F-94C STARFIRE, U. S. AIR FORCE'S ALL-WEATHER RADAR-EQUIPPED JET INTERCEPTOR, IS DEMONSTRATED IN THESE PHOTOS TAKEN DURING TESTS AT A CALIFORNIA BASE

(The sequence shows one plane touching down while the small pilot chute pulls a "package" containing the full-sized tight-reefed drag parachute from its special storage compartment above the tailpipe. In the lower picture, showing another plane, the 16-ft-diam deceleration chute has popped open and immediately begins to slow down the F-94C. The 600 mph-plus Starfire is the first American production fighter aircraft to have a drag-parachute installation.)

stallations, landing gear, and tires. To correct this problem, Lockheed decided during the development of the F-94C prototype airplane to install a deceleration parachute. After extensive tests were conducted with the Air Research and Development Command, the Starfire became the first production fighter aircraft to have a drag parachute installation.

Evidence of the chute's efficiency and economy came in Air Force tests in which 44 consecutive landings were made with one aircraft without the use of brakes except for taxi turns and ramp stops.

Statistics compiled by Lockheed engineers indicate that tire and brake life will be approximately doubled with 100 per cent chute utilization and average runway conditions. In addition to saving wear on vital parts, landing distance can be reduced 40 per cent through use of the chute.

Extensive testing by Lockheed engineers and the Wright Air Development Center parachute specialists determined the size and type parachute best adaptable to a plane such as the Starfire.

The first model parachute utilized was a Fist (ribbon) type 11 ft in diameter, with 24 per cent porosity and a drag coefficient of 0.49. The parachute was stowed in the most logical area available, a Fiberglas compartment built into the tail cone fairing directly above the tail pipe.

A 10-ft steel line, made of three super flex cables $^1/_4$ in. in diameter was attached to the release hook in the stowage compartment and to the nylon chute riser. Steel line was utilized in this area close to the tail pipe because of high temperatures of the jet wake. The nylon riser extended 15 ft to the serving at the lower end of the shroud lines.

In this experimental installation a 24-in-diam pilot chute was thrust into the slip-stream by the action of the compartment doors, opening at the start of the deployment cycle, withdrawing the parachute assembly from the compartment.

Later in the F-94C production-model installation the parachute was changed to a 16-ft-diam model with the same 24 per cent porosity and the same 0.49 drag coefficient as the 11-ft experimental parachute. Chutes with lower porosities were flight-tested but exhibited lateral instabilities.

The riser length on the production chute was reduced to 7 ft and a deployment bag was developed for the production installation. This arrangement proved highly dependable. Use of the deployment bag gave the advantage of consistent packing practice and also allowed prepacking of the parachute.

Time saved through parachute prepacking meant an important reduction in operational aircraft "turn-around" time.

In average packing practice, it is possible to arrange the chute in the deployment bag in 5 min and stow the deployment bag in the aircraft ready for flight in $1^1/_2$ min. The deployment bag weighs $1^1/_2$ lb and causes little increase in weight of the entire system, which is approximately 65 lb.

Concurrent development determined that the 10-ft steel drag-line, which was stiff and bulky, was not mandatory, and it was replaced with a 10-ft nylon line shielded from the heat by a Fiberglas sleeving.

Use of the nylon drag line considerably reduced the tendency for the drag line to whip when the chute was deployed and also decreased the amount of the opening shock load. The short time during which the nylon was subjected to jet wake heat during the deployment cycle made use of nylon feasible.

The mechanical part of the deployment system works in the following sequence: (1) The pilot pulls the chute-operating lanyard located in the cockpit compartment floor on the left-hand side. The first lanyard movement locks the hook to the link on the end of the drag line. (2) Further movement of the lanyard releases the spring-bungee-loaded doors, which snap open, releasing the pilot chute, drawing the deployment bag from the compartment, and starting the opening cycle. (3) After completion of the landing roll, the pilot rotates the lanyard handle 180 deg, and the next movement unlatches the hook in the tail cone, jettisoning the chute.

With this control arrangement, the parachute assembly is never locked to the hook in the aircraft until the pilot pulls the lanyard, as in Step 1. This insures absolute safety in the event the doors inadvertently open at low speed, such as on takeoff. The chute in this case would merely fall from the compartment, free of the aircraft.

An additional safety feature is a special heat-treated shear pin in the attaching link of the drag line. This pin, held to extremely close limits of yield and ultimate strength, will fail in shear just below the load which causes structural damage to the aircraft.

The system is designed for a 200-knot maximum speed. Successful deployments have been accomplished at low speeds down to 48 knots.

Because the load line of the drag chute passes through or very close to the center of gravity of the airplane, no pitch-over or pitch-up is encountered when the chute is employed. In many cases the pilot elects to use the parachute before touchdown. A motion-picture study of flight-test parachute landings showed that the parachute was being deployed when the aircraft was as much as 8 ft above the runway. Usual operation is from approximately 1 ft above the runway or just after contact.

Each chute is good for about 100 landings. This, compared to the expendable parachute expense of $250, means it costs only $2.50 per landing to use the chute—and gain both its economy and safety features.

Turbojet-Engine Simulator

A UNIVERSAL turbojet-engine simulator for developing, testing, and calibrating fuel-control components for gas-turbine engines has been created by Vickers, Inc., Detroit, Mich., in co-operation with the U. S. Navy Bureau of Aeronautics after two years of intensive research and development.

According to Vickers engineers, preliminary results indicate that the cost of final calibration of fuel controls on an engine can be reduced to about 2 per cent of their present cost by use of this engine simulator. The testing of a turbojet-engine fuel control has in the past involved little more than steady-state operation of the control at a number of discrete speeds within its operating range. This static type of test is at best a poor measure of whether the fuel control will operate satisfactorily with a particular engine, it was pointed out.

When coupled to an engine, a given fuel-control system may induce unstable operation even though the foregoing bench-test results are outwardly satisfactory. This apparent paradox can arise from an improper time constant in the fuel-regulating system, or any of the several dynamic effects in the control that are not revealed by the comparatively crude bench tests.

A further limitation of most of the conventional fuel-control test stands is their inability to maintain the speed of the control in the governing range of operation. This is a natural limitation originating in the negative power slope characteristics of the governing curves, but one which can be overcome with a properly designed test stand.

As described by Vickers, this engine simulator is composed basically of a power source and an infinitely variable-speed 100-hp hydraulic transmission for driving the fuel control, an engine simulator for representing the dynamic characteristics of turbojet engines, and the necessary equipment for operating the fuel control under closely regulated calibrating conditions representing the actual situations the control may encounter in actual flight.

The company revealed that several basic systems for powering the test stand were considered. Of these, the hydraulic transmission was selected because of the following advantages: (1) high ratio of horsepower to weight and size, (2) rapid and stable response to control signals, (3) accurate and infinitely variable-speed control, and (4) usable speed range from 0 to 100 per cent of rated speed.

A single engine simulator is readily adaptable to testing fuel systems for all current gas-turbine engines including (1) turboprop engines, (2) turbojet engines with fixed area tail, (3) turbojet engines with afterburner, (4) turbojet engines with variable area tail, and (5) turbojet engines with variable area tail and afterburner.

It was reported that with this device it will be possible for engine manufacturers to have a newly designed fuel system thoroughly tested and developed prior to its installation on a prototype engine. This procedure should eliminate many costly months presently devoted to conducting fuel-system development work on experimental engines.

Clad Steels

DISSIMILAR metals are now being bonded together more frequently than ever before, according to *Steel Facts*, April, 1953. For example, the use of steel plates permanently clad with thicknesses of copper, stainless steel, nickel, or other metals, increased over 2000 per cent between 1939 and 1951, according to a recent estimate by a steel executive.

Developed, but not widely used commercially until the 1930's, bonding of metals helps the user to meet requirements that cannot be met with one metal alone. Economy and the need for conserving strategic metals are among the other strong factors influencing the use of clad steel.

Clad steels offer a variety of unique characteristics which make them extremely valuable for specialized uses. Clad metals can be drawn, spun, bent, twisted, flame-cut, sheared, punched, or otherwise formed as though they were a single metal. When properly made, the two dissimilar metals cannot be physically separated in the normal course of fabrication or in use. And, in the broad selection of available clad steels, there is one which meets the requirements of almost any application, such as corrosion resistance, abrasion resistance, bearing applications, high strength, oxidation, heat and electrical conductivity.

The cladding material can be permanently bonded onto the steel by a number of methods. Some of these are by the use of heat and pressure, welding, casting, or other methods. The method of manufacture most widely used today, especially in producing clad steels for use as a material of construction for industrial equipment, is the "sandwich method." This employs heat and pressure to bond materials together.

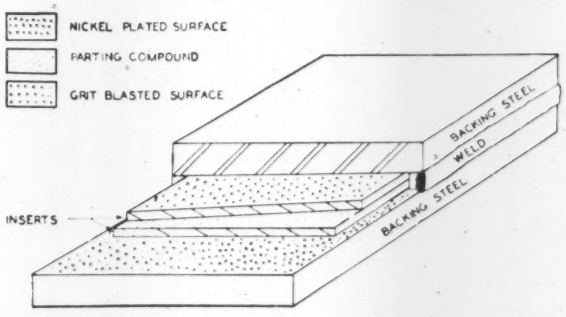


FIG. 4 VIEW OF A FOUR-PLY PACK ASSEMBLY FOR THE MANUFACTURE OF STAINLESS CLAD STEEL

In the sandwich method of cladding steel, two slabs of steel form the outer layers. Between the steel slabs are placed two plates of the cladding material which are separated from each other by a special parting compound. Both the steel slabs and the plates of cladding material are of a predetermined thickness which is calculated to produce the exact thickness of the clad-steel plate after rolling.

The sandwich is welded around the edges so that the components of the pack will not slip or separate during processing and to protect the surface of the cladding material during heating and rolling. The pack is then heated and rolled on a plate mill. After rolling, the welded edges are trimmed from the pack and the sandwich is separated into two clad-steel plates—each with the cladding material permanently bonded to the steel backing plate. A similar method is used for cladding steel on both sides, or, in some cases, the cladding material is cast around the steel slab.

The makers of clad steels look forward to conquering new fields, perhaps with the aid of such metals as tantalum, titanium, and zirconium, said one executive recently.

Conductive Rubber

RUBBER has been known for years as the ideal insulator and it still is. However, in 1934 researchers discovered that by compounding with certain types of carbon blacks, rubber could be made to have an electrical resistance of less than 100 ohms.

Two broad groups of such rubber compounds which conduct electricity have been developed. One is conductive rubber which refers to any rubber with a resistance of less than 100,000 ohms. When the main property required is to prevent accumulation of static electricity on road vehicles, flooring, belting, hose, footwear, etc., a nonstatic rubber having a resistance greater than 100,000 ohms can be used.

Conductive rubber has introduced a new safety factor wherever it is necessary to immediately discharge accumulations of static electricity. In the case of airplanes, for example, the fuselage often becomes highly charged with static electricity in flight. Unless this is discharged to earth immediately on landing, resultant sparks during refueling could lead to fire and explosion. One tire of conductive rubber eliminates this possibility.

Tires of nonstatic rubber prevent the accumulation in a car of the electricity that causes radio interference and so frequently shocks passengers on alighting. Perhaps an even more important use of nonstatic rubber is in hospitals. Used in mattresses, sheeting, footwear, and general apparatus, it eliminates the danger of fire and explosion that could otherwise occur during operations and other hospital activities. These explosions are brought about by accumulation of static charge on the bodies of the patient and hospital staff, or upon adjacent movable equipment, due to movement over insulated surfaces during an operation.

For similar reasons, nonstatic rubber footwear is applicable for work in explosive factories where a spark discharge can cause tremendous damage and in other industrial plants where fire is a hazard. It is also used in the manufacture of industrial hose, cables, belting, chute linings, and other applications where its nonspark feature provides a needed safety factor.

While conductive and nonstatic rubbers radically change the insulation quality, there is no change in any of the rubber's other normal qualities. Rubber has long been known as man's most versatile commodity. It is now more so than ever.

The issue of "Rubber Developments" containing the full description of conductive and nonstatic rubber is available without cost from the Natural Rubber Bureau, 1631 K Street, N. W., Washington, D. C.

Coal-Partial-Combustion

PLANS for building a production-scale unit to utilize a new, continuous, and soot-free process for producing synthesis gases were disclosed recently by DuPont Company.

The process, known as coal-partial-combustion, was evolved in eight years of research by the Belle Works technical section and may eliminate coke ovens and gas generators, standard for years in the conversion of coal into basic products of industrial chemistry, at the Du Pont Belle Works, W. Va., together with their inevitable smoke and soot. Besides providing an answer to air-pollution problems inherent in the old system, the process is expected to be considerably more efficient in the use of coal.

To build the coal-partial-combustion unit, said to be the first of its kind in the country, and dismantle portions of the gas-generating equipment which it will replace, will cost more than $4,000,000. Dismantling work has been started.

Additional new synthesis-gas units would have to be built to replace all of the capacity of existing facilities. The coke ovens and gas generators, the company pointed out, will be the only significant sources of soot remaining at the plant after completion early next year of a $2,300,000 fly-ash abatement installation in the boiler house.

Synthesis-gas manufacture is the heart of operations at the plant with many major products dependent upon it, including nylon intermediates, ammonia, urea, "Zerex" permanent-type automotive antifreeze, and starting materials for the plastic, "Lucite" acrylic resin.

In the new process, low-fusion-ash coal, instead of less plentiful coking varieties, will be crushed and reduced to the fineness of talcum powder in pulverizing equipment which will smash coal particles against each other in steam-driven jets.

The pulverized coal will be blown into a ceramic-lined furnace where, at carefully controlled temperatures, the volatile matter and fixed carbon will be burned in the presence of steam and a deficiency of oxygen to give carbon monoxide and hydrogen.

Carbon monoxide, except as used in the manufacture of ethylene glycol and certain other products, will be reacted with steam to give hydrogen and carbon dioxide, which are readily separated. Hydrogen and nitrogen, the latter obtained in the production of oxygen from the air in separate equipment, will be used in making ammonia.

The bulk of the ash will be drawn off as slag, and lightweight particles will be caught in filtering equipment.

The combustion furnace used in the pilot plant was designed in co-operation with and built by The Babcock & Wilcox Company which also will build the large-scale furnace.

Heavy-Press Erection

COMPLETION of installation of a 14,000-ton extrusion press at Aluminum Company of America's Lafayette, Ind., plant, moved the nation's heavy-press program a big step forward. Erection of the press, a product of Düsseldorf, Germany, was completed on April 1 in a record four months by F. H. McGraw & Company, New York, N. Y., equipment erection specialists. To give an idea of the assembly procedure of such a large press, Figs. 5 to 10 present some of the intermediate erection steps.

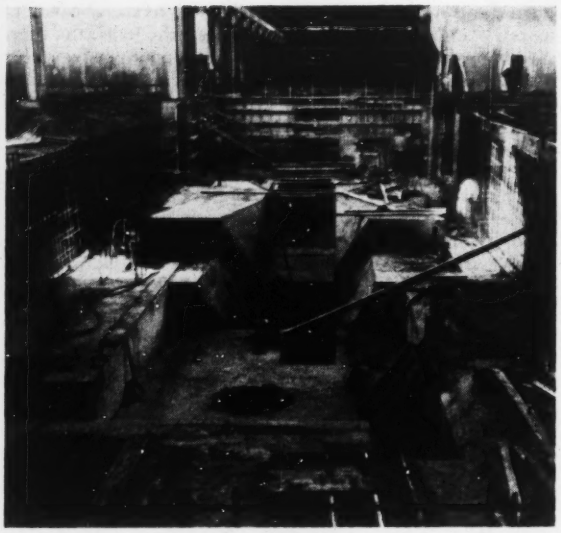


FIG. 5 CONCRETE FOUNDATIONS ARE IN PLACE FOR 14,000-TON EXTRUSION PRESS

(Walls are shown still being formed. Foundations required a 16-ft excavation measuring 32 ft wide, 125 ft long, and requiring 2500 yd of concrete. The foundations, which in some places were 8 ft thick, were installed by National Fireproofing Company.)

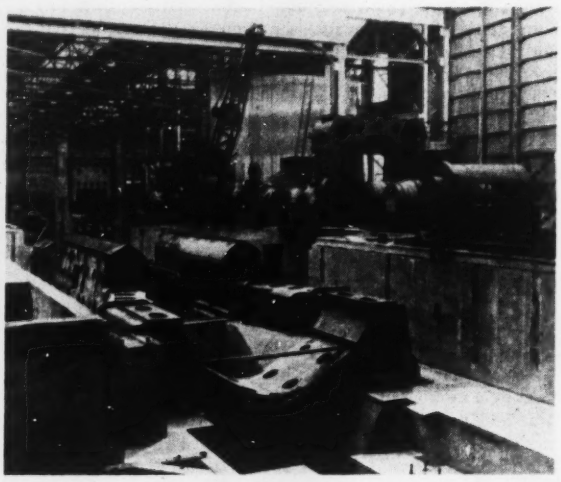


FIG. 6 BASE PIECES FOR HEAVY EXTRUSION PRESS ARE SHOWN IN PLACE WITH MORE PARTS OF THE GERMAN PRESS LINED UP BESIDE PIT READY FOR HOISTING INTO POSITION

(A Lorain crane, *background*, was used for lifting and assembling lighter pieces up to 32 tons in weight. Press parts were skidded from loading dock, approximately 160 ft to position beside foundations. It took 12 days to get pieces from where they were unloaded to press site. Parts were skidded by using 15-in. channels on top of two 110-lb rails. This reduced the heaviest piece, 107 tons, to a 38,000-lb line pull. A 210-International Truck with a 20-ton winch was used to skid the pieces to where they could be picked up with a crane.)

One of the first to be installed as part of the U. S. Air Force program, the new press is capable of extruding aluminum products nearly four times heavier than those coming from presses now in operation. It takes a billet 31 in. in diam and, because of its size, can extrude larger and more intricate shapes for tomorrow's airplanes. In a wing panel, for instance, the

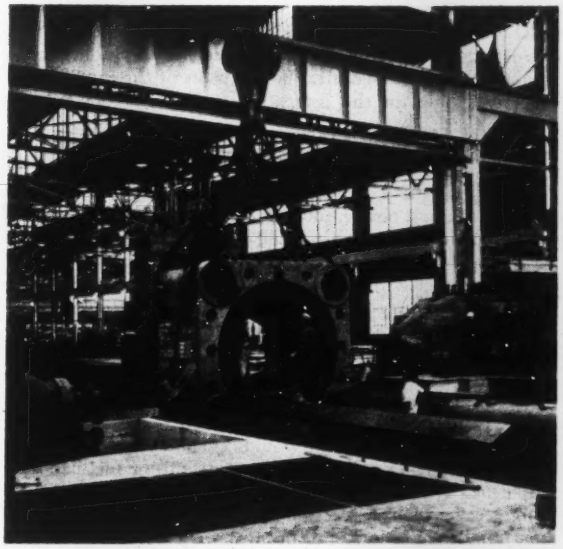


FIG. 7 OVERHEAD CRANE LIFTS HEAVIER PIECES OF PRESS
(Here, platen is shown being fitted into position. Weighing 103 tons, it was the second heaviest piece.)

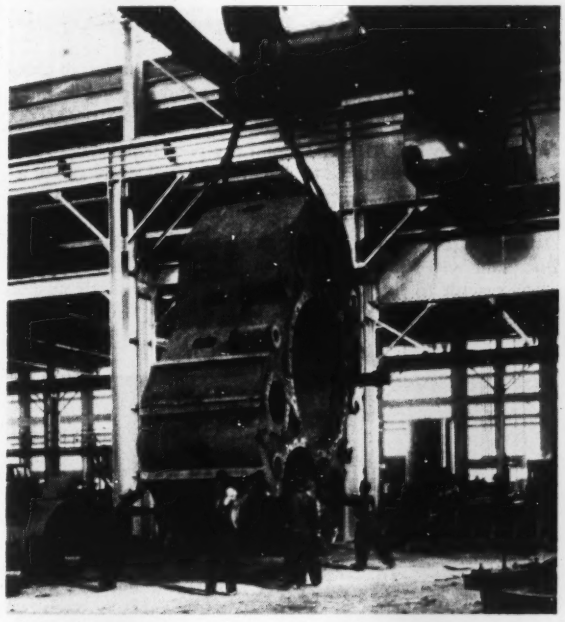


FIG. 8 HEAVIEST PIECE ERECTED WAS THIS 107-TON HOUSING
(The piece was carried to the press site with the overhead crane. Because the cylinder housing had to be properly positioned before it was assembled to the press, the piece had to be carefully turned and maneuvered, and aligned by the McGraw crew. After cleaning, greasing, and checking, it was lowered into place.)

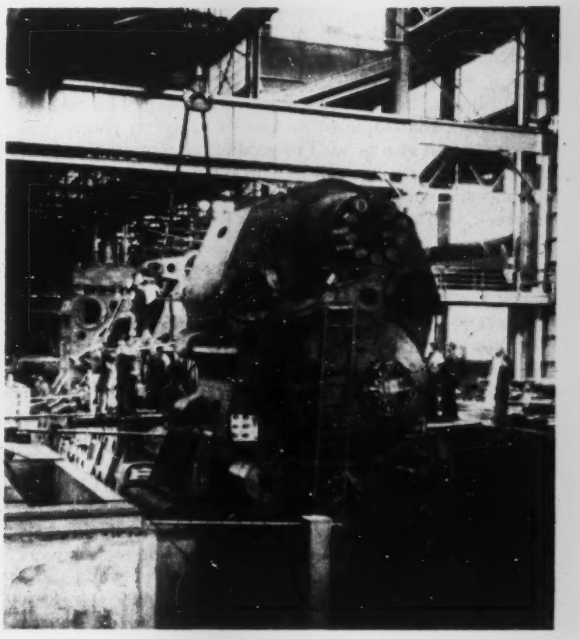


FIG. 9 CYLINDER HOUSING SHOWN IN PLACE
(Installed in upright position, the piece stood 23 ft high, was 8½ ft wide, and 14 ft thick. Once in place, the housing was bolted down and accessory parts added. This was one of the last big pieces to be installed.)

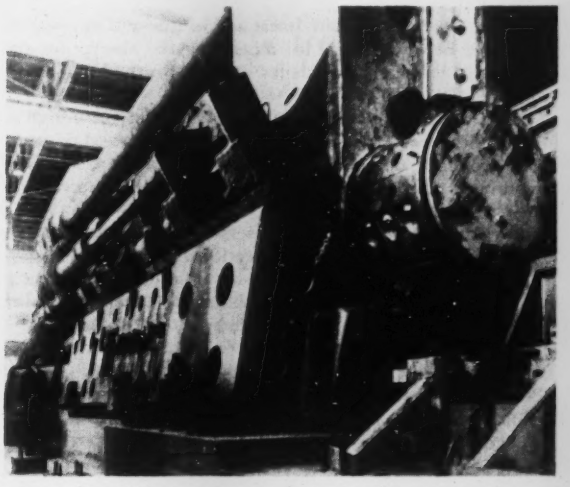


FIG. 10 14,000-TON EXTRUSION PRESS COMPLETED AND READY FOR TESTING
(Press is 125 ft long, 20 ft wide, and 27 ft high. The press is hydraulically operated; water and air pressure, 5000 psi. McGraw's peak crew on the job was 26 men—6 ironworkers, 8 millwrights, 6 laborers, 2 crane operators, 1 truck driver, 1 engineer, 1 accountant, and a superintendent.)

greater width will mean a stronger airplane skin with less weight and less riveting.

First call on all production by the press will go to the government under a lease arrangement between Alcoa and the U. S. Air Force.

Assembly of the press started in December, 1952, and, according to A. J. Jones, McGraw superintendent on the erection job, the installation was somewhat complicated by German calibrations and specifications which had to be translated into English. Special measuring devices with German calibrations and their English equivalents had to be used. One casting, the cylinder housing, weighed 107 tons. The platen weighed 103 tons.

Transportation of the press castings also posed a problem when they were unloaded in New York late this summer. They had to be shipped on five specially built railroad cars and could not be moved any faster than 30 mph—then only during daylight hours. More than a month was required for reloading in New York and shipment to Alcoa's Lafayette plant.

The press can also be used to produce aluminum pipe for the petroleum industry as well as curtain walls for ultramodern buildings and strong alloy shapes for the marine, railroad car, bus, truck, and trailer industries.

30-Ton Hand-Operated Door

A 30-TON door that opens with the touch of a hand has been installed at Yale University, New Haven, Conn., recently.

Four feet thick, the door provides the only entrance to the 20 × 40-ft inner chamber in Yale's new underground atomic laboratory, where a 20-million volt linear accelerator is scheduled to begin operation late this summer.

Usually, such massive doors into atomic chambers have been motor-driven, but Yale engineers developed this one for reasons of simplicity, economy, and safety. They particularly cite the safety angle, since a power failure could not lock a worker in the chamber during a dangerous period.

Construction on the underground laboratory which will house the accelerator began late last summer after Yale signed a contract with the Atomic Energy Commission.

The present laboratory, which has been built into a hillside on the north-central portion of Pierson-Sage Square, is the first unit of a large physics building program planned at Yale.

The new 20 million-volt accelerator will replace an 8 million-volt machine.

When completed, the new linear accelerator will be operated as a pulsed neutron source for measuring the absorption and scattering of various materials for neutrons in the high-energy range.

Such measurements are of vital importance for the design of future nuclear reactors. The new machine is expected to create pulsed atomic beams having an electron current from 5 to 10 times higher than beams produced by any similar accelerator now in existence.

At this stage of construction, the 30-ton door has attracted considerable attention from construction engineers.

The massive door and its mate—a second door about 50 ft down a narrow concrete hall—are viewed as a step forward in such construction. The second door, by comparison, is small—only $2\frac{1}{2}$ ft thick and weighing a mere 18 tons. It, too, moves easily by hand.

Both doors hang on giant tapered roller-bearing hinges anchored in the 6-ft reinforced-concrete wall of the atomic chamber.

Steel casings for the doors were cast by the Farrel-Birmingham Company of Ansonia, Conn., and were put into place before concrete was poured into them.

Despite their tremendous weight they move smoothly and without sound. Once in motion they also can be stopped readily by hand. They are hung with such precision that they fit tightly into the thick door-wall of the blasting and measurement chambers of the laboratory.

Nuclear Power Plant

THE design of an 8000-kw nuclear-powered pilot plant to produce electricity for civilian use was announced at a technical press conference in New York, N. Y., recently by North American Aviation, Inc., of Los Angeles, Calif. A scale model of the pilot plant, complete with flashing lights, moving control rods, and clicking Geiger counter, was exhibited as an example of the atomic central power plant of the future. The model was built in the company's research laboratories at Downey, Calif.

Demonstrating the scale model, Dr. Chauncey Starr, director of North American's Atomic Energy Research Department, explained that the proposed pilot plant would generate about 8000 kw of electric power, enough to supply 2000 average homes with electricity. This power could be utilized for other atomic-energy research to be done at the site of the reactor.

Electric power will be generated in the pilot plant from the tremendous quantity of heat produced by the atomic-fission process, Dr. Starr pointed out. This heat will be absorbed by a liquid metal passing through the reactor and will be piped into an ordinary water boiler to produce steam. The steam would then be used to drive a conventional turbine-generator to produce electricity.

Externally, the pilot plant would resemble an ordinary electric power plant, except for lack of coal, oil, or fuel-handling equipment. Also there would be no smoke or fumes.

Engineering for construction of such an atomic plant could begin immediately, with full operation expected in about two years, Dr. Starr said.

J. H. Kindelberger, chairman of the company's board, said there are just three simple technological facts for demonstrating this model for the design of an atomic power plant:

1 To develop power from nuclear reactors, it is necessary to build pilot plants.

2 We can build a pilot plant on the basis of our design using our engineering and production facilities and starting at once.

3 Our estimate of cost of such a pilot plant is $10,000,000.

According to J. L. Atwood, company president, the purpose of the pilot plant would be to demonstrate and study the practical and economical aspects of electric-power production by a nuclear reactor of this specific design.

It is expected, he said, that research and experience with the pilot plant will result in the future design of a larger atomic-energy reactor to produce electricity on the same scale as conventional central-station electric-power plants using ordinary fuel or water power.

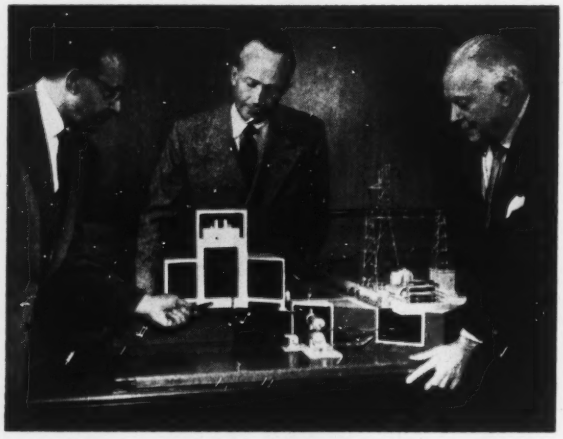


FIG. 11 SCALE MODEL OF PILOT NUCLEAR PLANT

(Dr. Chauncey Starr, *left*, describes scale model of proposed pilot plant for the generation of electric power from atomic energy as J. L. Atwood, *center*, and J. H. Kindelberger look on.)

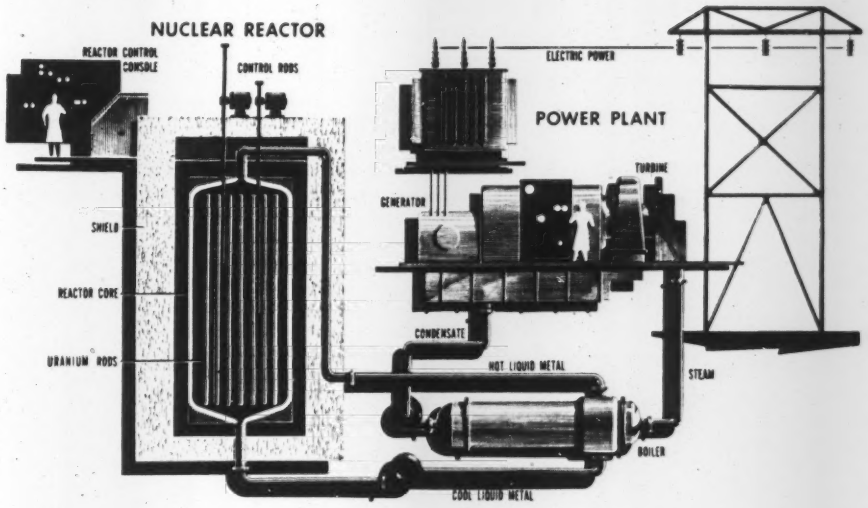


FIG. 12 SIMPLIFIED SCHEMATIC DRAWING OF NORTH AMERICAN'S PROPOSED 8000-KW NUCLEAR-POWER PILOT PLANT

(Heat produced by the atomic-fission process in the reactor, *left*, would be absorbed by a liquid metal passing through the reactor core. The liquid metal then is piped to a boiler, *lower center*, where steam is produced. The steam would drive a turbine generator, *center*, producing electricity.)

Mr. Atwood emphasized that North American is not in the business of selling electric power, nor does it intend to enter the field, but is ready to work with industry or an industry-government combination on this project to make atomic-power generators practical and feasible for those who are in that business.

This nuclear reactor, designed specifically to produce electricity, was developed by North American under contract with the Atomic Energy Commission.

Certain phases of the North American design are classified as restricted data under the Atomic Energy Act. The plans are available for inspection through the Commission by all persons and concerns cleared for access to restricted data.

Thermal Test Reactor

A MINIATURE low-power nuclear reactor has been placed in operation as a research tool at the Knolls Atomic Power Laboratory, Schenectady, N. Y., which is operated by the General Electric Company for the Atomic Energy Commission.

Contrasted to huge reactors at the company's Hanford Works, Richland, Wash., the new reactor is contained in a cube of graphite measuring only 5 ft on a side, according to Dr. Kenneth H. Kingdon, technical manager of the Knolls laboratory.

While a low-energy reactor of this sort cannot be used for making plutonium, or for the production of atomic power, it is a useful source of the atomic particles called neutrons, which can be utilized in many fields of fundamental research, Dr. Kingdon said.

The device, called a thermal test reactor, consists fundamentally of the graphite cube, with the atomic fuel in an 18-in. aluminum tank inside a cylindrical hole in the center of the graphite.

The fuel consists of "enriched" uranium, in which the amount of U235, the kind that undergoes the energy-producing process of fission, has been increased. Because of its enrichment only about 6 lb of such fuel are required, Dr. Kingdon noted.

In the operation of such a reactor, he explained, the uranium 235 atomic nuclei split into two parts, by fission, and as they do so neutrons are given off at high speed. Passing through the graphite, which serves as a moderator, they are slowed to thermal speeds, about the same as those of ordinary oxygen and nitrogen atoms in the air of a room. Such speeds, however, average more than a mile per second.

Some of these thermal neutrons, hitting the uranium fuel elements, cause fission of more U235 nuclei and thus the chain reaction is maintained.

Describing details of construction, Dr. Kingdon said that the fuel is in two-inch disks of an alloy of uranium and aluminum, strung on rods like beads on a string and kept apart by plastic separators. Each rod, about 18 in. long, is hung in a can containing a light paraffin base oil. There are 20 such cans in a circle, with water between them.

In the middle of the ring of fuel cans is a graphite cylinder 12 in. in diam, with a test hole in the center. Materials to be tested or to be exposed to neutrons are placed in this hole, where they are subjected to a strong neutron bombardment as the reactor is operated. In addition, materials can be inserted into the reactor through a horizontal hole from outside the protective walls, which extends close to the fuel assembly.

Control of the device is accomplished with rods and sheets of cadmium which can be lowered into the fuel assembly. These blot up neutrons and so prevent them from carrying on the chain reactions. Other safety rods are provided which drop automatically into place when needed.

As installed at Knolls, the device is inside a cell 10 × 15 ft, surrounded by a 6-ft-thick concrete wall. Access to the cell can be attained through an opening 3 ft wide, with a motor-operated concrete door. This door must be closed and locked before the reactor can be operated.

To detect minute amounts of certain elements, Dr. Kingdon said, the reactor is first operated at a uniform level. Then, by remote control from outside the cell, the test sample is lowered into the central test hole. Depending on the material, there will be some additional absorption of the neutrons, thus slowing down the operation of the reactor. Then the control rods are withdrawn to restore the original operating level. From their settings, as compared with their previous positions, minute amounts of elements affecting the operation can be detected, he said.

Steam Power

High-Pressure High-Temperature Unit

DEVELOPMENT of a new boiler and turbogenerating unit, designed to cross the barrier of the "critical pressure" of steam for the first time in the commercial production of electric power, was disclosed recently. It is reported that it will be

the most efficient generating unit ever built and will utilize the unprecedented steam pressure and temperature of 4500 psi and 1150 F, respectively.

Announcement of plans to build the unit was made by Philip Sporn, Fellow ASME, president of American Gas and Electric Company; Alfred Iddles, Fellow ASME, president of The Babcock & Wilcox Company, and Glenn B. Warren, Fellow ASME, vice-president of General Electric Company and general manager of its Turbine Division.

After many months of study and preliminary design, the three companies have reached agreements under which General Electric will design and manufacture a 120,000-kw turbine, and Babcock & Wilcox will design and build the boiler for it. The turbine, at 4500 psi, will operate at almost double the present highest steam pressure utilized for power generation. The initial steam temperature 1150 F will be 50 degrees above the present highest and will be followed by two stages of reheat, the first at 1050 F and the second at 1000 F. The boiler will be the "once-through," Universal-Pressure type, in which water at 5500 psi is pumped through and changed into superheated steam in a single fast passage through the tubes in the boiler. It will be equipped with cyclone furnaces to insure rapid and complete burning of the coal and prevent air pollution.

The entire project, cost of which will exceed $12 million, is being engineered by American Gas and Electric Service Corporation, a subsidiary of American Gas and Electric Company. The new unit will be installed under Service Corporation supervision at The Ohio Power Company's Philo Plant near Zanesville, Ohio. Ohio Power is an AGE operating company subsidiary.

In commenting on the project on behalf of the three companies associated with it, Mr. Sporn pointed out that it was the consummation of more than 30 years of continuous work and development on the AGE System to bring about more economical methods of power generation and that the three companies have co-operated during the past three decades on a large number of other projects looking toward the same objective.

"Many new ideas in turbine, boiler, and plant design will be incorporated and tested in this development," Mr. Sporn stated. Among these are the use of: (1) steam pressure above the critical pressure of 3206 psi, (2) initial steam temperature of 1150 F, and (3) more than one stage of reheat.

"While the use of boilers above the critical pressure of 3206 lb had been considered before and while laboratory pressures above that value had been utilized," Mr. Sporn said, "no practical design had ever been developed." He explained that, in the supercritical pressure range, water passes immediately into steam, without any intermediate stage of "bubbling," such as is observed in a pot of boiling water at atmospheric pressure or exists in a boiler operating at any pressure below 3206. The use of this Universal-Pressure type boiler means that the boiler drum (the biggest and heaviest single item of equipment in a power plant), used to separate the bubbles of steam from the water, and recirculating pumps are not required.

"It is this that in part makes the once-through idea so attractive," Mr. Sporn said. "The boiler becomes, in effect, a continuous run of tubing into which water is pumped at one end and out of which highly superheated steam is delivered at the other end." In such a boiler, the feedwater is not delivered to a central drum. Instead, it passes directly from a newly designed feed pump through the boiler unit and is heated and converted to superheated steam at 1150 F, passing through the boiler and superheater just once.

The principle of reheat of steam is used in the most modern power plants to practically utilize every ounce of energy contained in it. In the new Philo generating unit, the "double heat" method will realize even greater efficiencies. It involves leading the steam back into the boiler setting twice for reheating during its passage through the turbine.

"The use of higher pressures, higher temperatures, and new ideas in reheat at Philo," Mr. Sporn declared, "will make possible not only new world standards of efficiency in generation of steam-electric power, but ultimately will make possible capital reductions by compressing size of units and bringing about more effective utilization of materials. In this work there will be available the background of experience of the last 30 years along similar efforts integrated by the three organizations—AGE, G.E., and B. & W.

"Even more important," he continued, "is the fact that the successful development of power generation at this new plateau of higher pressures and temperatures will make possible in time still higher pressures and temperatures and additional reheats and resulting efficiencies hardly visualized a few years ago. Efficiencies of conversion of the heat in fuel into electric energy of the order of 50 per cent are distinct possibilities. Certainly they loom on the horizon."

The new Philo Plant unit will be a developmental model and relatively small as modern generating units go. However, to cross the barrier of critical pressures, new concepts of turbine design will be required for this machine. Its 120,000-kw capacity will increase net generating capacity of Philo Plant—one of Ohio's largest—to 495,000 kw. It will replace, and use the building now occupied by, a 40,000-kw unit built in 1923.

260,000-Kw Unit

It was also announced by Glenn B. Warren that a steam turbine-generator unit which, it is said, will be the largest in the world, has been ordered from the General Electric Company by The Detroit Edison Company.

The new unit, to be installed in the River Rouge Station of the Detroit utility, will have a turbine rated 260,000 kw. Its generator, rated 353,262 kva, is designed for conventional hydrogen cooling.

The machine will be of the cross-compound, double-flow, reheat design developed by General Electric since World War II.

In this type of machine, steam first enters the high-pressure turbine at a pressure of 2000 psi and a temperature of 1050 F. Steam is exhausted from the high-pressure turbine at about 720 F and is returned to the boiler where it is reheated to 1000 F before re-entering the turbine.

After being exhausted from the low-pressure turbine, the steam is condensed and returned to the boiler where the process starts again.

The new unit will produce enough electric power to fill the needs of more than 700,000 people. Over 830,000 tons of coal will be needed each year to provide steam for the turbine. Converting the turbine's exhaust steam back into water will require more than 140,000 gpm of cool water to be circulated through the condensing unit.

A modern General Electric turbine-generator such as the River Rouge machine will use less than $\frac{3}{4}$ lb of coal to make 1 kwhr of electricity.

The River Rouge Station will be an entirely new power station to fill the mounting electric-power requirements of the Detroit area. The new turbine-generator is scheduled for shipment in the summer of 1955.

Industrial Laboratories

ABOUT two thirds of the nation's research and development work is normally done in industrial laboratories. However, when defense requirements are high, much of this work is actually government-backed. For example, in 1952 about

half the $2.3 billion worth of research done by industry was supported by government funds, mostly through contracts with the Department of Defense and the Atomic Energy Commission. This was one finding of a recent survey by the Research and Development Board of the Department of Defense and the Bureau of Labor Statistics as reported in the *Industrial Bulletin* of Arthur D. Little, Inc., March, 1953.

The amount of defense work varies sharply with the industry; aircraft companies are most heavily committed to defense projects, with 85 per cent of their research funds coming from government contracts, according to the survey. The figure is 60 per cent in the electronics industry, but it is down to seven per cent for chemicals, and only three per cent for petroleum refining. Three major industries—electrical machinery, chemicals, and aircraft—account for 55 per cent of the $2.3 billion spent on research and development and also for 55 per cent of the professional personnel employed.

Not only are professional scientists and engineers concentrated in a few industries, but in a relatively small number of companies within each industry. More than a third of the 235,000 research workers employed by companies reporting (which account for about 85 per cent of the nation's industrial research) are employed by less than 20 companies having professional research staffs of 1000 or more. Less than two per cent are with the 600 companies which have a staff of less than five. The ratio of professional to "supporting" workers averages 1 to 1.5 although this ratio again varies with the individual industry and with the total research staff. Most government support goes to the larger groups. Companies with research staffs over 500 average 56 per cent government research; those having less than 500 average 35 per cent.

Research expenditures, expressed as a percentage of total sales, are frequently used as a measure of a company's relative standing in its own industry. The survey shows that new yardsticks are needed in times of defense effort. The 2000 companies covered reported an average of two per cent of sales spent on research and development. The range, however, was from 13 per cent for the aircraft industry to less than one per cent for food, textiles, and primary and fabricated metals. The chemical industry averaged 2.5 per cent.

While, in general, costs per research worker are higher in big laboratories, these costs also vary widely with the industry. Stimulated by the need to operate more efficiently for defense purposes, the higher-cost research organizations of today are trying to bring their expenses more into line with the average, largely through greater and more efficient use of supporting personnel.

Ultrasonic Machine Tool

AN ultrasonic machine tool that uses a sound wave to drive the cutter through such hard materials as steel, glass, stone, ceramics, or even precious stones, has been developed by Raytheon Manufacturing Company, Waltham, Mass. The machine was first used for mixing so-called immiscible liquids. Now the device, which employs "magnetostrictive" principles, has been developed into a machine tool which is expected to have widespread applications in many metalworking industries.

The present form of the machine is most nearly like that of a conventional drill press. Other models that may enable it to perform the functions of a lathe, milling machine, boring mill, shaper, planer, saw, and router are being developed.

A feature of the machine is that the cutting tool can be made of relatively soft material, such as cold-rolled steel, or brass, yet the tool will cut through hard steel, stone, cast iron, or even sapphire.

The motion of the tool is invisible, for it travels only a few thousandths of an inch each way. The extreme speed of this motion, however, is the key to its efficiency. According to one of the Raytheon scientists who helped develop it, the ultrasonic machine tool works as follows when drilling, for example, an ordinary round hole:

The work is clamped firmly in place, and the tool is lowered until it is in contact with the surface. A liquid abrasive is flowed over the work in a continuous stream. Then the power is turned on. The tool, vibrating at approximately 27,000 times per second, drives the abrasive particles at ultrasonic speed. These extremely small particles strike the work at 5000 to 10,000 times their normal weight, due to the acceleration which they have been given by the ultrasonic tool. This action cuts away the material.

On very hard substances, such as glass, each traverse of the tool may cut into the work an immeasurable distance, perhaps only the depth of a few atoms. Yet the tremendous repetition rate utilized enables the tool to make a significant rate of progress through the work.

Such difficult materials as alnico, tungsten carbide, boron carbide, quartz, optical glass, molybdenum, and carbon may be machined quickly and accurately with this new machine tool, according to Raytheon. The work need not be a conductive material.

Accuracies of a very high order may be maintained, regardless of the material being cut, it is claimed. The actual tolerances are limited by the accuracy of the die being used, or the dimensions of the shaped tool, and the accuracy of the feed and ways of the machine.

Corrosion Measurements

AN interferometer procedure is being used at the National Bureau of Standards, Washington, D. C., for studies of the corrosion resistance of such materials as optical glass, porcelain enamel, quartz, and other natural and artificial silicates, and various metals. The method is believed to have value for comparing and predicting the chemical durability of various materials. Although interferometers have been widely used in science and industry for such problems as checking the accuracy of block gages, measuring expansion, and checking optical "flats," they have apparently been used very little in previous studies of corrosion resistance. With the highly sensitive interferometer method, corrosion to a depth of as little as 1 or 2 ten-millionths of an inch can be detected on optically flat specimens.

In the NBS technique, specimens are ground and polished to optical flatness and then immersed to half their depth in the desired corrosive solution. After the desired length of time they are withdrawn, rinsed, and dried, and covered with an optically flat piece of quartz. Using a conventional interferometric viewing apparatus of the Pulfrich type, and with an unfiltered helium lamp for illumination, the displacement of the optical interference fringes at the level-of-solution line of the specimen is observed.

As seen by the observer looking into the eyepiece of the instrument, these interference fringes are vertical parallel lines. If the uniform flatness of the specimen under study has not been impaired by the corrosive solution, these fringes are straight and continuous. However, if the previously immersed part of the specimen surface has been sensibly attacked, each of the vertical fringes is shifted laterally at the point where it crosses the change-of-thickness line. If, as sometimes happens, the solution has caused swelling of the specimen, the lateral shift

is in the opposite direction. A lateral shift equal to the space between two adjacent fringes corresponds to a dimensional change in the specimen amounting to one-half wave length of light, or roughly 0.3 micron. (A micron is a millionth of a meter or about 40 millionths of an inch.) With careful use of the interferometer, changes in specimen thickness of as little as 0.003 micron can be detected.

Silicates studied by this procedure at NBS were quartz, fused silica, opal, obsidian, flint, and pitchstone. Porcelain enamels studied were acid-resistant, class A; "glass-lined" tank; and acid-resistant, class D. Metals were cold-rolled steel, aluminum, copper, brass, silver, and platinum. The corrosive agents ranged from concentrated sulphuric acid (H_2SO_4) to 5 per cent sodium hydroxide (NaOH) solution. Exposure times were as short as one minute and as long as several weeks. Temperature in most cases was held at 80 C.

A number of interesting and sometimes unexpected results were obtained. Swelling of the immersed surface, rather than attack, was found in several cases. For instance, crystalline quartz showed definite swelling after two weeks at 80 C in an acid solution (pH 4.1). Opal—like quartz, a form of silica (SiO_2)—showed a swelling of nearly one fringe of light at pH 2 and continued at a similar level to about pH 8; between pH 8 and pH 11, however, the swelling changed rapidly to an attack of $3\frac{1}{2}$ fringes. Although brass was attacked by strongly acid and strongly alkaline solutions, there was a slight indication of swelling in the more nearly neutral solutions. Such apparent swelling could perhaps be caused by the formation of a layer of insoluble salt having greater volume than the metal from which it was formed. Of the metals studied, only platinum showed no detectable dimensional change under the laboratory conditions. The three types of porcelain enamels studied varied widely in their chemical inertness as indicated by the test.

Mines Diesel Locomotive

A REVOLUTIONARY type of diesel locomotive has been introduced by the Hunslet Engine Company, Ltd., Leeds 10, England, specially for underground service. It is only 39 in. high but is able to start and pull well over 600 tons along the level at $5\frac{1}{2}$ mph. It has a four-speed gearbox giving track speeds of $5\frac{1}{2}$, 7, $9\frac{1}{2}$, and 14 mph, and is powered by a 170-hp horizontal oil engine. Maximum tractive effort is about 11,000 lb and the weight 37,000 lb. The 24-in. wheels are spread over a base of 7 ft and over-all length is 18 ft. Full flameproofing and exhaust conditioning are included. The height is believed to be the lowest ever achieved with a locomotive carrying its own source of power. Though Hunslet has built several hundred flameproof mines diesel locomotives for five continents, this particular model is said to be the most powerful mines diesel locomotive in the world.

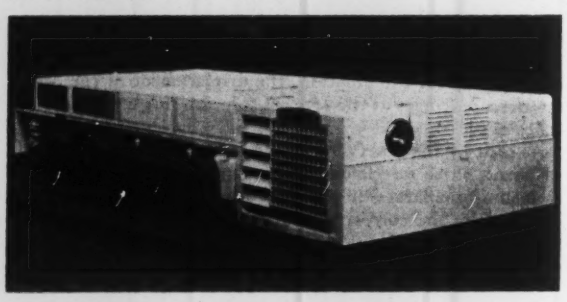


FIG. 13 GENERAL VIEW OF 3-FT 6-IN-GAGE 170-BHP 37,000-LB FLAMEPROOF MINES DIESEL LOCOMOTIVE

It has been produced specially for the United States market to replace electric trolley locomotives. The oil engine installed, a Cummins horizontal model, was chosen because of the widespread servicing and spares facilities which exist for it throughout the U.S.A.

Heat-Pump Field Trials

EXPERIENCE and results of field tests on three residential air-to-air heat pumps were reported in a paper presented by G. L. Biehn, design engineer in the Sturtevant Division Westinghouse Electric Corporation, before the American Power Conference in Chicago, Ill., recently.

Summer air-conditioning units for either individual room or entire home cooling have been available for a number of years, Mr. Biehn said. The new heat pumps just tested are designed to supply either cooled or heated air to every room throughout the year.

By assuming the position of a home owner, Westinghouse believed it could quickly and simply find the answer to important questions all consumers ask about products, namely, how much does it cost to operate and maintain?

Three different climatic areas in the United States were chosen for installation of the test units. The southeast was represented by a five-room bungalow in Miami, Fla; the southwest, by a five-room ranch-type home in Fort Worth, Texas; and the northern fringe area, by an eight-room ranch-style house in Lynchburg, Va. After the selection of the cities, the power companies supplying service to the respective areas were contacted to enlist their co-operation. Not only did they assist in making initial installation, but they also provided service to the units, collected the data, and maintained the instruments.

The air-to-air heat pumps are regulated by a single three-stage room thermostat. There is a five-degree differential between the heating and cooling stage, and a two-degree differential between normal heating and the booster heat stage. For example, a thermostat set at 74 F would control the heating stage at this temperature. Booster heat would come on at 72 F and cooling at 79 F. A switch mounted on the thermostat permits manual control of the air-circulating fan.

At the Lynchburg, Va., residence, the cost of operation of the heat pump for the first year averaged $33.10 per month at the $1\frac{1}{2}$ cents per kwhr rate for this region.

Further south in Miami, Fla., the heat-pump operation costs averaged $10.50 per month. This figure is based on the local $1\frac{1}{2}$ cents per kwhr rate. Cooling is the prime requisite in Miami; thus the cost is accepted as a rather nominal addition. It was the heating that made the impression on the home owners here, however, since the usual type of heating used in this area is not too comfortable.

Although a full season has not quite been completed at the Fort Worth, Texas, installation, present data indicate that the operational cost will be less than $40 per month. The rate including demand charges and fuel adjustment is somewhat over two cents per kwhr.

As expected, a few minor adjustments were required when these units were installed and first operated. There have been no failures of any major part of the units and none of the hermetic systems have been opened since they were put into operation.

Each of the three families in whose homes the heat pumps were installed found the system to be more than satisfactory in every respect. They were especially fond of the heating due to the lack of drafts or dryness generally present in other types of hot-air heat.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

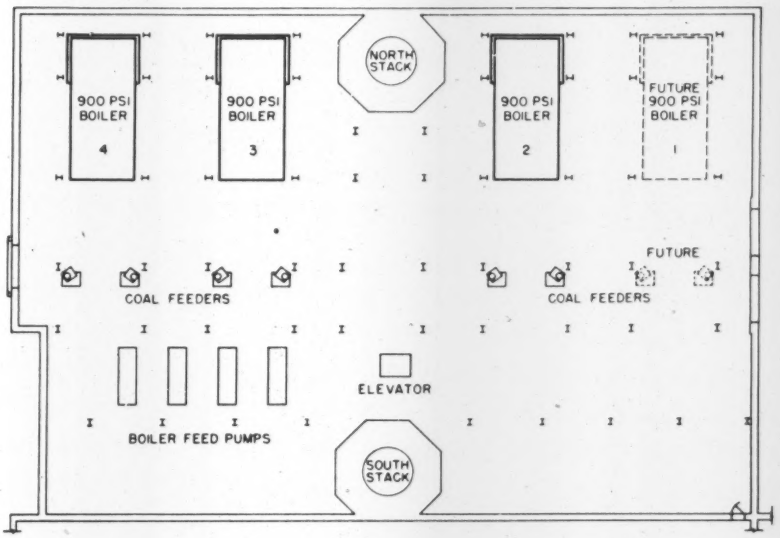
Steam-Power Generation

Rehabilitation of an Industrial Power Plant, by C. E. Morrow, Mem. ASME, and R. F. Born, Mem. ASME, Western Electric Company, Chicago, Ill. 1953 ASME Spring Meeting paper No. 53—S-14 (mimeographed).

AT the conclusion of a study conducted to determine how to meet most economically increased demand for manufacturing energy at Hawthorne Works in Chicago, Ill., it was necessary to supply management with certain basic information in order to justify the expenditures finally recommended. In this report the reason for the increased energy demand was shown and its permanency established. Increased cost in the two variables having the greatest effect on the cost of energy generation, i.e., fuel and labor costs, were discussed and their effect on variable power costs shown. The most economical method to decrease the use of these variables was developed. Construction costs were estimated together with operating costs to be expected with the new equipment. As it was necessary to replace existing low pressure with higher-pressure steam generators, a plan was developed to insure safe dependable operation and an estimated progress schedule worked out.

The paper presents this information in much the same way it was given to management with the benefit of a minimum of hindsight. In addition, the construction schedule is reviewed, the estimated first cost compared with resultant cost of construction, and the costs resulting from actual operation compared with those forecast.

It was concluded that for this type of manufacturing the energy demand per productive man-hour has increased at a constant rate and indications are this increase will continue. For this reason the cost of such energy will become more and more a factor in the cost of items produced. With high demands for energy other than electric power, where this energy can be economically produced by steam at relatively low pressures, it should be so produced. For manufacturing processes requiring large amounts of steam at relatively low pressures together with a corresponding electric-power demand, energy purchased from a utility is not competitive. For certain combinations of steam and electric-power demand and with the co-operation of the utility company involved, an arrangement providing for an interchange of energy



PLAN VIEW OF NEW BOILER PLANT AT FIRING FLOOR

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profitable to both the utility and the customer can be worked out. By arranging equipment to burn the fuels available in the area, worth-while savings can result from purchase in distressed markets.

Chemical Cleaning in Central Stations, by P. H. Cardwell, Mem. ASME, Dowell Incorporated, Tulsa, Okla. 1953 ASME Spring Meeting paper No. 53—S-19 (mimeographed).

IN order to remove the various scale deposits found in central-stations equipment, this paper states, it is necessary to use acid solvents, alkaline solutions, emulsions of organic liquids in an aqueous alkaline media, and thickened acid solvents. Besides the various solvents which must be used, it is necessary to employ different treating techniques such as the filling and soaking method; the jetting at high pressures in order to mechanically break up the deposit; the spraying of thin or thick solvents onto the scale when it is present in large vessels or tanks; the circulating technique to remove organic materials; and the introduction of chemical solvents while the equipment is in service.

Improved acid inhibitors are now being used in the acid solvents. These polyethanol amine products give better protection than the coal-tar nitrogen-sulphur-type inhibitors, especially on stressed areas, on zones having dissimilar grain sizes, and on metals containing the Widmanstatten structure.

The problem of ferric iron corrosion has been investigated. While it seems to be impossible to make direct chemical measurements as to the extent, if any, of this type of corrosion, experimental results indicate that the ferric chloride is reduced by the nascent hydrogen formed by the reaction of acid with the steel. The reduction of ferric chloride by this procedure does not dissolve any additional boiler metal over that normally dissolved by the acid.

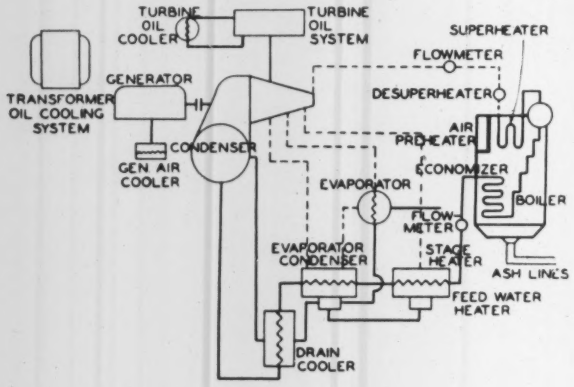
The Solubility of Oxygen in Water, by L. M. Zoss, Taylor Instrument Company, Rochester, N. Y., S. Suciu, Jun. ASME, General Electric Company, Schenectady, N. Y., and W. L. Sibbitt, Jun. ASME, Purdue University, Lafayette, Ind. 1953 ASME Spring Meeting paper No. 53—S-30 (mimeographed; to be published in Trans. ASME).

THE solubility of oxygen in water was measured at pressures of 1000, 1500, and 2000 psia and at temperatures from 32 to 625 F.

According to the paper, oxygen shows unusually high solubility at 32 F. The solubility decreases with the increasing temperature in the range from 32 to 200 F and then increases with increasing temperature.

At room temperature where the gas solubility is small the fugacity of the water in the liquid phase may be calculated from Raoult's law. If the pressure change is small then Henry's law applies to the dissolved gas. When the solubilities of gases are measured at high pressures then the influence of pressure cannot be disregarded; consequently, the usual expression for Henry's law must be corrected. A knowledge of the partial molal volume of the dissolved gas is needed in order to make this correction. These data for oxygen are not available.

Henry's law, it is pointed out, can not be used to predict the solubility over a wide pressure range. Actually, the solubility would increase to a maximum value and then decrease with increasing "partial pressure" of oxygen.



SCHEMATIC DIAGRAM OF EQUIPMENT WHICH CAN BE CHEMICALLY CLEANED IN A STEAM-GENERATING SYSTEM

Fuels

Natural-Gas Peak-Load Problems in the Appalachian Area, by C. T. Konecny and B. J. Clarke, Columbia Gas System Service Corp., Columbus, Ohio. 1953 ASME Spring Meeting paper No. 53—S-28 (mimeographed).

A DISCUSSION of the growth of the natural-gas industry in the Appalachian area with particular reference to the use of underground storage as a means of meeting peak-load demands is presented in this paper. The nature of space-heating loads is shown and the necessity for using a "low-investment" method such as underground storage for meeting these demands is demonstrated. The advantage of and the operating problems in such an operation are discussed. Estimates of future trends are also presented.

During 1951, sales to retail and wholesale customers in the Appalachian area plus company usage totaled over 450 billion cu ft of gas. This compares with a total annual volume of almost 300 billion cu ft of gas in the year 1948. Dealing with such an expansion in a short period of time is at best a difficult problem. It is magnified considerably by the nature of the demand curve of the customers taken on by the System since 1946. Since that time the bulk of the newly acquired load has been space-heating service with its inherent sensitivity to outdoor weather conditions.

A large portion of the gas distributed in the Appalachian area (about two thirds in 1951-1952) comes from the Southwest. Since cross-country pipe lines cannot be economically operated at much below 100 per cent load factor, pipe lines from the Southwest cannot be utilized exclusively to meet demands for this gas. The probably optimum solution to the problem is the one that utilizes the largest portion of the equipment at high load factors. Up to the present the economic solution has appeared to be utilization of underground storage areas as close to market areas as possible. This permits contracting for a relatively constant daily delivery of natural gas from the Southwest which can be sent directly to market or stored as the market demand dictates. Thereby, the necessity of paying demand charges for gas not received, or the necessity of finding markets at a lower price for off-peak gas is eliminated. The end result is that only the facilities beyond the storage area are subject to low-load factors. Consequently, within certain limits of development costs, the closer the storage area is to the markets, the more ideal the situation.

An Investigation of the Burning Characteristics of Pulverized Cinders, by J. M. Allen, Battelle Memorial Institute, Columbus, Ohio. 1953 ASME Spring Meeting paper No. **53—S-2** (in type; to be published in Trans. ASME).

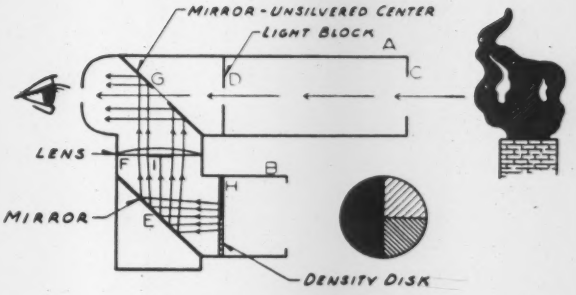
PULVERIZED locomotive cinders were burned in a laboratory furnace so constructed that the degree of completion of burning could be determined as a function of the residence time of the particle passing through the furnace. Variables whose effects were studied include fineness of pulverization furnace temperatures, excess air, and extent of preheat. The completion of burning indicated for an arbitrary residence time of 0.25 sec in the furnace was increased by (*a*) an increase in the fineness of pulverization, and (*b*) an increase in furnace temperatures under normal conditions of 25 to 30 per cent excess air. Preheating the air supply and the pulverized cinders to 600 F had a beneficial effect on the initial burning rate, but had very little effect on the ultimate degree of completion of burning.

The Smokescope—An Instrument for Estimating the Density of Smoke in Stack Effluent, by John P. Strange, Mine Safety Appliances Company, Pittsburgh, Pa. 1953 ASME Spring Meeting paper No. **53—S-3** (mimeographed).

AN instrument for estimating the density of smoke in stack effluent has been developed in the Mine Safety Appliances Company research laboratory which eliminates the causes of error which are inherent in previously described devices. To eliminate the effect of differences in lighting, a reference standard film disk is viewed against the background adjacent to the stack. In this manner the smoke and the reference film receive light from the same source. Smoke-density estimations are therefore unaffected by background variations, or by the brightness of the day.

To further improve the accuracy with which smoke-density estimations can be made, a lens has been used to project a virtual image of the reference standard to a focal distance equivalent to that of the stack. This makes it unnecessary to refocus the eye while making a comparison. The optical system limits the field of vision to the area of the stack and eliminates stray light, also the effect of ambient light.

Operation of the smokescope can best be understood by referring to the accompanying diagram. The stack is viewed through the instrument and the smoke is seen through the apertures C, D, and the center section of image mirror, G. These apertures limit the field of vision to the area of the stack and prevent entrance of stray light. Light from the area adjacent to the stack is transmitted through the reference film disk, H, in barrel, B, to the front surface mirror E. By means of this mirror and lens, F, an image of the reference film is placed upon the image mirror where it may be compared with the smoke as seen through the apertures. By placing the reference film at the focal point of the lens the light rays reaching the eye from the film are made parallel, thus projecting the virtual image of the reference film to infinity. The area of film is small and acts as a point source. Comparison of the smoke density with the reference can then be easily made without changing the focus of the eye.



LINE DIAGRAM OF SMOKESCOPE

Heavy-Duty Operation of Spreader Stokers, by M. W. Jones, Mem. ASME, Columbia-Southern Chemical Corporation, Barberton, Ohio. 1953 ASME Spring Meeting paper No. **53—S-27** (mimeographed).

THIS paper shows how one manufacturer increased total boiler capacity by replacing multiple underfeed stokers with continuous-ash-discharge spreader stokers. It covers some of the problems encountered due to the heavy-duty operation of the spreader stokers on a load that is continuous 24 hours per day and seven day per week.

The paper points out that spreader stokers will operate successfully under heavy-load conditions with low-grade coal, and discusses the shortcomings so that they can be avoided on future installations. Anyone contemplating the installation of a spreader stoker should carefully consider the following points:

1 Check boiler baffling for leaks and sharp turns, and eliminate turns with open-pass baffle.

2 Check gas velocity and maintain entrance velocity to economizer under 50 fps.

3 Check coal sizing and limit amount of fines to 35 per cent below $^1/_4$ in.

4 Provide adequate overfire air with control if load variation is great.

5 Check complete boiler setting for leaks to get maximum air through grate in order to protect grate and produce better ash.

6 Provide for discarding dust from dust collector.

Thermodynamic Properties of Combustion Gases, by Gilbert S. Bahn, Jun. ASME, General Electric Company, Schenectady, N. Y. 1953 ASME Spring Meeting paper No. **53—S-39** (mimeographed).

THERMODYNAMIC data determined for evaluation of combustion-chamber performance are presented in this paper as calculation tools for similar developments. The desire for precise data covering the field of interest led to assignment of specific values to several independent variables for which data were calculated. The resulting graphs all deal with combustion of hydrocarbon fuels in inlet air of moderate pressure, temperature, and humidity. Use of the graphs is demonstrated by several examples.

In the course of developing a liquid-hydrocarbon combustion chamber to operate at 3000 F, precise theoretical data were required for the calculation of combustion efficiency. Good combustors all have nearly 100 per cent efficiency, and thus the comparison of one with another involves fractions of a per cent in the efficiency values. It is necessary to acknowledge the frequent use of data for the calculation of combustion efficiency which are considerably less precise than the indicated precision of the computed values. First consideration of this situation seems to depreciate the benefit of very exact theoretical bases for calculation. However, in final analysis the best answer to the problem lies in an approach to precise data by means of statistical collection of data points with highly refined instrumentation. If a curve must be drawn and interpreted in the

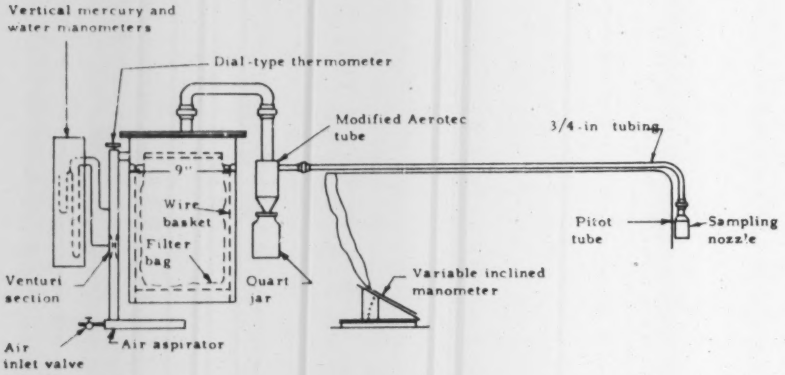
light of unprecise experimental foundation, reliability is further impaired by ignoring small theoretical discrepancies.

The essence, therefore, of the work reported in this paper is as follows: To secure the precision desired, and unavailable in the more comprehensive data of other workers, values of enthalpy, combustion temperature, and combustion-temperature rise were computed as functions of temperature and fuel/air ratio. The influences of initial air temperature, fuel carbon/hydrogen ratio, and air humidity were included as primary variables, rather than as correction factors. Dissociation at higher temperatures was accounted for at static pressures of 1, 2, and 3 atm abs.

Dust Emissions From Small Spreader-Stoker-Fired Boilers, by Elmer J. Boer, Jun. ASME, Bituminous Coal Research, Inc., Columbus, Ohio, and Charles W. Porterfield, Jun. ASME, Pocahontas Fuel Company, Inc., Pocahontas, Va. 1953 ASME Spring Meeting paper No. **53—S-26** (mimeographed).

WITH an increased emphasis on the need for reducing air pollution from all sources, there has been a greater interest in the problem of collecting fly ash and cinders from coal-fired boilers—particularly in those plants where spreader stokers are used. Although the greater emphasis naturally falls on cleaning up the larger spreader-stoker installations, the small spreader-stoker-fired plants are already receiving the attention of air-pollution-control officials.

Tests were conducted on four small spreader-stoker-fired plants to determine dust emissions at the boiler outlet under various test conditions. Results indicate that the dust emissions increase when (1) the proportion of extreme fines in the coal increases, (2) the rate of heat release increases, (3) the excess air increases, and (4) on-off controls are used in place of modulating controls. The results of these tests are reported as dust loadings at the boiler outlet and are helpful in selecting dust collectors which may be used to reduce the final stack emissions to conform with air-pollution-control ordinances.



SCHEMATIC ARRANGEMENT OF DUST-SAMPLING APPARATUS

Industrial Instruments

An Analysis of the Dynamics of Hydraulic Servomotors Under Inertia Loads and the Application to Design, by Harold Gold, E. W. Otto, and V. L. Ransom, National Advisory Committee for Aeronautics, Lewis Flight Propulsion Laboratory, Cleveland, Ohio. 1953 ASME Spring Meeting paper No. **53—S-1** (in type; to be published in Trans. ASME).

THE servomotor discussed in this paper is a power-amplifying, positioning device of the type used in such applications as control-valve positioners, flight controls, and power steering devices. The experimental and analytical study of the dynamics of the hydraulic servomotor recently completed at the Lewis Laboratory develops data demonstrating the nonlinear, discontinuous nature of the dynamic response of the servomotor. It includes a derivation of the basic analytical expressions for describing the response.

The analysis shows that the response characteristics of hydraulic servomotors may be described in terms of two physical parameters—The no-load time constant and a dimensionless term, the inertia index. The no-load time constant is a function of the dimensions of the servomotor and the pressure drop across the servomotor. The inertia index is a function of the dimensions of the servomotor, the load mass, and the magnitude of the disturbance.

Design equations based on these two parameters have shown that, for a fixed-response specification and load mass, the motor size and the motor rigidity decrease and the peak cylinder pressure increases when the inertia index is increased. Designs based on values of inertia index approaching zero will result in very large servomotors. Designs based on values of inertia index in excess of six result in high-peak cylinder pressures and may lead to instability as a result of oil compressibility. Designs based on values of inertia index between 1 and 4 should result in servomotors that are very satisfactory from a standpoint of size, structure, and response, and in which the effect of oil compressibility is negligible.

Phase-Plane Analysis—A General Method of Solution for Two-Position Process Control, by Donald P. Eckman, Mem. ASME, Case Institute of Technology, Cleveland, Ohio. 1953 ASME Spring Meeting paper No. **53—S-17** (mimeographed; to be published in Trans. ASME).

TWO-position or on-off control is one of the most important as well as one of the simplest modes of control in both industrial and domestic applications, the paper states. Two-position control is frequently employed in engine and other machine controllers. In spite of its wide use, two-position control has not been adequately treated from the analytical viewpoint because of the essential nonlinearity of the system; that is, because the operation of the system is not described by a single linear differential equation.

The analysis of two-position control has been made for certain simple cases by the method of differential equations by Oldenburger and Saxtorius and by the method of Fourier Series by Ivanoff. Although these analyses are valid for the cases considered, they are not sufficiently general to enable the solution of important industrial applications.

The phase-plane analysis presented in this paper follows the approach to nonlinear systems presented in Minorsky and by MacColl.

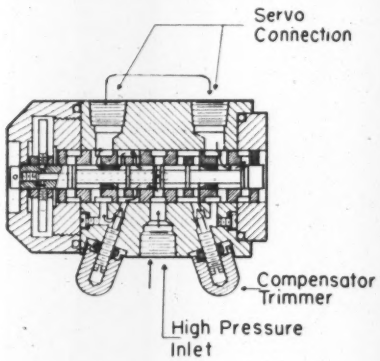
The phase-plane method of analysis requires transforming the differential equations for the closed-loop into co-ordinates of rate of change of deviation versus deviation. Then, by integral equations, the period and amplitude of oscillation of process control may be evaluated. Five interesting problems in process control are discussed. The limitations of the analysis are that process-control

problems involving differential equations of higher order than second cannot be evaluated exactly.

For process-control problems, an approximation of the response by a Ziegler-Nichols method of approach can be used in a very simple manner. Problems involving various nonlinearities may also be solved.

Dynamic Operation of a Force-Compensated Hydraulic Throttling Valve, by John L. Bower, North American Aviation, Inc., Downey, Calif., and Franz B. Tuteur, Yale University, New Haven, Conn. 1953 ASME Spring Meeting paper No. **53—S-25** (mimeographed; to be published in Trans. ASME).

ONE of the greatest difficulties in the design of hydraulic servomechanisms in which a throttling valve is used as the major control element is the determination of the transfer characteristics of the valve. The reasons for this are partly the basic nonlinearity of the relations between flow, pressure, and valve opening, and partly the hydraulic reaction forces which depend on pressure and flow and which greatly affect the dynamic operation of any valve driven by a force source of finite stiffness.



CROSS SECTION OF G.E. VALVE

In this paper an analysis of a standard valve is undertaken which results in the desired transfer function provided that the input amplitude is small. The analysis also results in an explanation for the erratic oscillations which often occur in these valves and provides methods for controlling or eliminating them.

The valve analyzed is a three-land type of about two-horsepower capacity, manufactured by the General Electric Company. The stem of this valve is continuously rotated at a speed of about 3000 rpm by a small reaction turbine so that static friction effects are minimized. A system of dams and adjustable passages is interposed into the flow paths in an attempt to compensate for the hydraulic reaction forces. Although the analysis applies specifically to this valve, it is sufficiently general to apply to valves of similar design with different power ratings and with a different degree of complexity. For example, a valve which has no force compensation is a special case of the valve dealt with here and is covered by the analysis. Since, however, static friction between moving parts in the valve has not been considered, the behavior of valves in which this is a large factor would probably not be completely predicted by this analysis.

Production Engineering

Economical Inspection Procedures Based on Inspection-Cost Break-Even Points, by L. W. Dockray and R. F. Garrett, Western Electric Company, Kearney, N. J. 1953 ASME Spring Meeting paper No. **53—S-4** (mimeographed).

THE development of a method for determining the most economical process-inspection plan in a manufacturing plant is discussed in this paper.

Consideration is given to the merits of eliminating defective product at an early stage of the manufacturing process by means of an inspection operation compared with the cost of eliminating defective product in subsequent manufacturing operations. Simple mathematical derivations are provided for evaluating the merits of the basic types of inspection plans normally available in a factory.

Typical examples are described and developed to illustrate the available inspection plans. Curves are included to show the characteristics of the various inspection methods under varying conditions of process average, cost of inspection, and cost of repair in assembly.

On the Analysis of Cutting-Tool Temperatures, by E. G. Loewen, Jun. ASME, and M. C. Shaw, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1953 ASME Spring Meeting paper No. **53—S-15** (mimeographed; to be published in Trans. ASME).

IN modern machine-tool practice cutting temperatures are assuming increasing importance as cutting speeds and feeds are increased and new materials of construction are introduced. Methods are available for experimentally determining the mean temperature on the tool face of a cutting tool. However, it is not possible to determine experimentally the influence of many of the variables influencing this temperature, nor to measure conveniently its components.

The analytical procedure to be followed in computing cutting temperatures is presented in this paper and illustrated by several examples. Relative importance of the several variables influencing tool-face temperatures is discussed and the variables of real significance are listed in order of importance. The only thermal quantity of the system of importance is the product of the thermal conductivity and the volume specific heat of the workpiece. Analytical results are employed to explain the unusually high temperatures that are observed in the machining of titanium alloys.

Distribution of Shear-Zone Heat in Metal Cutting, by W. C. Leone, Jun. ASME, Carnegie Institute of Technology, Pittsburgh, Pa. 1953 ASME Spring Meeting paper No. **53—S-7** (in type; to be published in Trans. ASME).

THE paper presents an expression for the fraction of thermal energy developed at the shear zone in orthogonal metal cutting which is conducted back into the workpiece. The shear-zone temperatures calculated using this expression are found to compare favorably with those measured indirectly by Trigger and with those calculated by use of Hahn's inclined-source solution.

Metal Processing

The Effects of Cold Drawing, Microstructure, and Thermal Treatments on the Machinability and Mechanical Properties of Carbon and Alloy Steel, by Ford E. Dreves, Wyckoff Steel Company, Newark, N. J. 1953 ASME Spring Meeting paper No. **53—S-8** (mimeographed; to be published in Trans. ASME).

THIS paper describes the role of the cold-finished steel mill in the field of metal cutting. With constant advances in machining techniques, the mill is looked upon to supply closer-controlled material to meet the demands of the production engineers and machinists. Production engineers are now more conscious of metal-cutting economics than ever before. They are confronted with innumerable factors that affect machinability. However, they desire more knowledge of the tangible factors such as the material, and how it will affect their production, including second-

ary operations such as cold-crimping, heat-treating, and so forth.

Where cold-finished steel bars are concerned, there are several ways such bars can be produced, one of which may be the most suited for a particular application. The cold-finishing operations are briefly described. The effects of cold drawing on the machinability and mechanical properties of some common grades of steel is explained in the paper.

Microstructure plays an important role in the machining of all grades of steel. Its effect on the machinability of plain-carbon grades and medium-carbon constructional alloy grades is discussed, along with the common thermal treatments employed to control it. The advantages of stress relieving for certain applications is mentioned.

Gas Turbine Power

Calculation of Transpiration-Cooled Gas-Turbine Blades, by John N. B. Livingood, Lewis Flight Propulsion Laboratory, National Advisory Committee for Aeronautics, Cleveland, Ohio, and E. R. G. Eckert, Mem. ASME, University of Minnesota, Minneapolis, Minn. 1953 ASME Spring Meeting paper No. 53—S-37 (mimeographed; to be published in Trans. ASME).

A METHOD for an analytical determination of the local coolant flow required to maintain a constant prescribed wall temperature for a transpiration-cooled turbine blade is presented in this paper. Application of the method to an arbitrarily chosen blade shows the maximum coolant flow is required in the region about the blade stagnation point. The coolant flow rate decreases on either blade surface throughout the laminar flow region extending from the stagnation point to the minimum pressure points. Downstream from the minimum pressure points, turbulent flow prevails and a considerable increase in required coolant flow is found for this region.

Recovery factors for a transpiration-cooled flat plate are also included. For increasing coolant flow, the recovery factor is found to decrease considerably. In addition, verification of an existing method for correlating flow data for porous surfaces is presented from data taken at NACA.

Although the analytical study reported shows great promise for transpiration-cooled turbine blades, numerous difficulties remain to be overcome before it will be possible to actually obtain the flow rates required by the analysis. Some of these problems are discussed.

Some Theoretical Aspects of Centripetal Turbines, by Richard L. Robinson, AiResearch Manufacturing Company, Los Angeles, Calif. 1953 ASME Spring Meeting paper No. 53—S-38 (mimeographed).

ACCORDING to this paper, a one-dimensional approach to the centripetal turbine will allow the selection of the basic geometry of the turbine. This means that for a given condition of adiabatic head, rpm, and weight flow, the nozzle angle, wheel inlet and discharge angle, diameter ratio, and inlet and outlet areas can be determined to obtain optimum efficiency.

The general conclusion that can be drawn with respect to these geometry variables of the turbine is that the critical part of the centripetal-turbine design is in the exducer of the turbine. The analysis as presented in this paper is definitely limited in predicting the trends and performance for the centripetal turbine at the extreme off-design conditions. For most practical cases, however, the analysis provides an adequate range for predicting the turbine performance since the turbine operation does not get too far from the design point.

In the final analysis, it should be remembered that the geometry selected by the one-dimensional approach may not be a practical one because of strength and mechanical considerations, none of which were encompassed within the scope of this paper.

Hydraulics

Mixing and Equilibrium in Pipe Flow, by W. H. Carrier and W. S. Misener, Carrier Corporation, Syracuse, N. Y. 1953 ASME Annual Meeting paper No. 53—S-44 (mimeographed).

A SEMICLASSICAL approach to the problem of mixing or redistribution in pipe flow is developed and checked against a series of tests in which a jet was discharged into the open end of a pipe. The theory presented successfully describes the changes in velocity distribution as a jetlike peaked flow decays and, under proper conditions, offers a moderately good prediction of the change in total pressure. There is some indication that the theory can be extended to cover normal pipe flows.

The test data are of considerable independent value and are tabulated in detail with typical cases plotted to illustrate the various phenomena measured. The momentum loss area of two typical cases is plotted vs. L/D, illustrating the way in which it reduces exponentially, overshoots its final value somewhat, then rises to assume the value corresponding to the Reynolds number. (L = length down the pipe, ft; D = pipe diameter, ft.)

Perhaps the most important single item arising from the present theory and tests is the concept of the decay coefficient and the fact that it is almost independent of Reynolds number. This would seem to indicate that the turbulent mechanism itself is not greatly affected by Reynolds number.

It is hoped that the success of the simple semiclassical approach used in predicting the performance of a symmetrical mixing flow in a pipe will provoke some productive thought and eventually result in some gains in our understanding of turbulent flow. It is hoped also that the data and simple theory will find some use among engineers for predicting pressure changes due to redistribution, the length of path required to reach an equilibrium condition, and interim velocity profiles.

The Unsteady-Flow Water Tunnel at the Massachusetts Institute of Technology, by James W. Dailey, Massachusetts Institute of Technology, Cambridge, Mass., and Kenneth C. Deemer, Mem. ASME, University of Kansas, Lawrence, Kans. 1953 ASME Spring Meeting paper No. 53—S-31 (mimeographed; to be published in Trans. ASME).

A PROJECT to investigate fluid friction and cavitation phenomena in unsteady motion is under way in the Hydrodynamics Laboratory at Massachusetts Institute of Technology. Its objective is to obtain for transient-flow conditions through conduits and around immersed bodies the same kinds of basic information that have been determined for steady-flow cases.

A pilot-model water tunnel, developed to produce flow in which the basic motion is accelerating or decelerating, is of unconventional design. It is of the blowdown type and consists essentially of two tanks 20 in. in diam and 6 ft 8 in. long, mounted vertically, one above the other, and connected by a tube, or working section of one inch ID. Flow from the upper tank passes through guide vanes and an entrance nozzle, through a quick-opening valve. The velocity and acceleration of the flow through the tube are governed by the difference in air pressure above the water surfaces in the upper and lower tanks. This differential pressure, in turn, is controlled by a servo system.

High-frequency-response electronic

cells were developed for measuring differential water pressures directly. These cells have been employed in experiments to determine loss of head along the test section and for measuring the instantaneous average velocity.

Oil and Gas Power

A Photographic Study of Events in a 14-In. Two-Cycle Gas-Engine Cylinder, by R. L. Boyer, Mem. ASME, and D. R. Craig, The Cooper-Bessemer Corp., Mount Vernon, Ohio, and C. D. Miller, Battelle Memorial Institute, Columbus, Ohio. 1953 ASME Spring Meeting paper No. 53—S-45 (mimeographed; to be published in Trans. ASME).

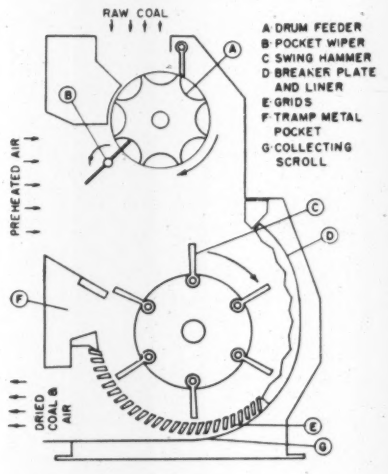
HIGH-SPEED photographs were used in a study of ignition, flame propagation, fuel injection, exhaust blowdown, cylinder scavenging, and turbulence in a Cooper-Bessemer GMV engine. Photographs were exposed, through glass windows installed in cylinder walls and cylinder heads, with the Isotransport camera designed and built by Battelle Memorial Institute. The research, sponsored by The Cooper-Bessemer Corporation, was conducted jointly by Cooper-Bessemer and Battelle personnel.

An important step accomplished during the early phases of the research was the complete elimination of lubricating oil in the combustion chamber of the engine. Such elimination of oil was essential to avoid its rapid deposit on the window and mirror surfaces within the chamber, which rendered photography impossible. An important incidental result of the research, therefore, was an indication as to where improvements might be made relative to oil consumption.

From the photographs, exhaust blowdown was seen to follow a pattern of laminar flow. Scavenging air, however, was found to enter the cylinder in turbulent jets. The inevitability of such jet action was fully predictable on a theoretical basis for any conceivable method of introducing air into the engine cylinder. Nevertheless, the existence of this phenomenon does not appear to have been recognized earlier. Recognition of such a nature of flow of air into any engine cylinder, suggested by the photographs obtained in this test program, is believed to be a significant advance in the understanding of engine operation.

The nature of scavenging air flow shown by the high-speed photographs appears to support loop scavenging in preference to other types that have been considered and tested by other means.

Photographs have indicated that satisfactory turbulence is achieved, from a combustion standpoint, together with satisfactory mixing of the injected natural gas with the cylinder contents. The jet action of the scavenging air apparently contributes greatly toward turbulence.



SECTION OF TEST CYLINDER SHOWING ORIENTATION OF FIELD OF VIEW FOR PHOTOGRAPHY THROUGH CYLINDER WALL

Investigation of Flame Temperatures in a Single-Cylinder Spark-Ignition Engine, by Prof. J. H. Potter, Mem. ASME, and R. B. Dillaway, Jun. ASME, The University of Illinois, Urbana, Ill. 1953 ASME Spring Meeting paper No. 53—S-46 (mimeographed; in type to be published in Trans. ASME).

THIS paper reports on experimental flame-temperature determinations in a spark-ignition engine using the electro-optical system proposed originally by Graff. For calibration, the sodium "D" line-reversal technique was employed.

Statistical methods were applied to the temperature-crank angle and pressure-crank-angle oscillograms obtained from the electro-optical technique, to reduce individual cycle values to average engine levels. The importance of the Graff method as a research tool is reviewed in the paper.

The following conclusions may be supported on the results of this study:

1 Individual temperature crank-angle cycles may be photographed. This makes it possible to study (a) temperature variation from cycle to cycle and (b) to determine maximum and minimum peak-cycle temperatures.

2 As evidenced by performance on different fuels, the results were free of the effects of chemiluminescence.

3 Because the method reports individual cycles, average cylinder temperatures must be determined from a great number of randomly selected cycles.

4 As this is not a primary method, the calibration must be undertaken with great care. Allowance must be made for variation of emissivity, for the geometry of the optical system, and for the concentration of the alkaline salt.

5 In common with most of the other optical methods for determining the flame temperature in the cylinder of an engine, the Graff technique gives only the average regional temperature for that portion of the cylinder volume in the optical path. Local temperatures in the cylinder may exceed this by a considerable amount.

6 There is need for further work on the Graff method. The present study is essentially a progress report which has been carried to the limit of performance of an old and unsuitable engine. Control of the basic engine parameters, over the ranges of modern operating conditions, is of prime importance. Simultaneous recording of successive pressure and temperature cycles, along with knowledge of the gaseous equilibrium constants, could yield new information on the combustion processes as they occur in the internal-combustion engine.

Heat Transfer

The Effect of Fin Geometry on the Performance of Heat-Exchanger Surfaces, by W. E. Hilding, Mem. ASME, University of Connecticut, Storrs, Conn. 1953 ASME Spring Meeting paper No. 53—S-42 (mimeographed).

THIS paper presents an analytical comparison of the effect of fin geometry on the performance of the heat-exchanger surface, with regard to total heat loss and volume or weight of extended surface. The effect of fin depth, thickness, spacing, and root-surface design is included.

The graphical representations of the results of this analysis indicate that it is desirable to use very thin, relatively short fins, spaced close together, down to one boundary-layer thickness. For example, in one case it is shown that a fin with triangular profile of 0.010 in. root thickness and 0.200 in. in length, spaced with 0.010 in. clearance between fins, is equal to thicker and longer fins

with regard to total base-surface heat loss and greatly superior to the same with respect to weight economy. It is readily admitted that the factors of strength and machinability enter into the picture under these conditions.

Application of the method of analysis used in this paper should help guide experimental efforts in the more profitable directions and will also present a system for the effective correlation of experimental results.

New Aspects of Natural-Convection Heat Transfer, by Simon Ostrach, National Advisory Committee for Aeronautics, Cleveland, Ohio. 1953 ASME Spring Meeting paper No. 53—S-43 (mimeographed; to be published in Trans. ASME).

AN analysis of the natural-convection phenomenon shows that the compression work and frictional heating may, depending on the magnitude of a new parameter K, be of consequence in this type of heat transfer. Consideration of the specific case of natural-convection flow between two parallel plates at constant wall temperatures indicates that the velocity and temperature distributions, and hence the heat transfer, are appreciably altered by consideration of the frictional heating.

Further, the results of this study predict two flow and heat-transfer states for a given set of conditions as well as a critical set of conditions beyond which no solutions exist. Therefore, to evaluate properly the practical utility of the natural-convection process, care should be taken to see if the compression work and friction heating are important in each particular case. In addition, the conclusion of the other problems outlined in this paper should yield the qualitative and quantitative characteristics of the natural-convection phenomenon under the new conditions.

Heat Transfer and Fluid Friction for Fully Developed Turbulent Flow of Air and Supercritical Water With Variable Fluid Properties, by R. G. Deissler, Jun. ASME, National Advisory Committee for Aeronautics, Cleveland, Ohio. 1953 ASME Spring Meeting paper No. 53—S-41 (mimeographed; to be published in Trans. ASME).

A PREVIOUS analysis for fully developed turbulent flow and heat transfer in smooth tubes with variable fluid properties for a Prandtl number of one is generalized in order to make it applicable to air and supercritical water. Calculated velocity and temperature distributions as well as relations among Nusselt number, Reynolds number, and friction factor for both air and supercritical water with variable fluid properties are presented.

Experimental local heat-transfer coefficients, friction factors, and velocity and temperature distributions, which were measured for air flowing turbulently in a smooth tube with heat transfer at large temperature differences, are included in the paper and compared with the analysis.

Substantial agreement was obtained between experimental and analytically predicted heat-transfer and friction correlations as well as velocity and temperature distributions for air. The best check of the analysis was obtained by measurement of local heat-transfer coefficients for air. Both the experimental and analytical results indicated that for Reynolds numbers above 15,000, the effects of ratio of wall to bulk temperature on the Nusselt-number correlation can be eliminated by evaluating the fluid properties in the Nusselt and Reynolds numbers at a temperature close to the average of the wall and bulk temperatures.

In using the preceding result it is important to use thermal conductivities and viscosities both proportional to the absolute temperature raised to the 0.68 power and constant specific heat.

The analysis indicated that the effect of variation of shear stress and heat transfer across the tube on the velocity and temperature distributions is slight for turbulent flow with variable fluid properties. It also indicated that the effect of molecular shear stress and heat transfer in the region at a distance from the wall is slight.

The analysis for supercritical water indicated that the effects of variable fluid properties on the Nusselt number and friction-factor correlations are eliminated by evaluating the properties in the Nusselt and Reynolds numbers at a reference temperature which is a function of both the wall temperature and the ratio of wall to bulk temperature.

ASME Transactions for June, 1953

THE June, 1953, issue of the Transactions of the ASME, which is the *Journal of Applied Mechanics* (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

TECHNICAL PAPERS

Stresses Due to Tangential and Normal Loads on an Elastic Solid, by J. O. Smith and C. K. Liu. (52—A-13)

Forced Lateral Vibration of Beams on Damped Flexible End Supports, by D. F. Miller. (52—A-23)

Frequencies of Longitudinal Vibration in Variable Section Rod, by J. L. Lubkin and Y. L. Luke. (52—A-27)

An Invariant Membrane Stress Function for Shells, by H. L. Langhaar. (52—A-18)

On the Plastic Strains in Slabs With Cutouts, by P. G. Hodge, Jr. (52—A-22)

Response of a Cylindrical Shell to a Shock Wave, by R. D. Mindlin and H. H. Bleich. (52—A-19)

The Origin of Damping in High-Strength Ferromagnetic Alloys, by A. W. Cochardt. (52—A-21)

Damping Constants and Stress Distribution in Resonance Response, by B. J. Lazan. (52—A-8)

Unsteady Radial Flow of Gas Through Porous Media, by R. Jenkins and J. S. Aronofsky. (52—A-26)

Pure Bending of an Incomplete Torus, by M. A. Sadowsky and E. Sternberg. (52—A-17)

Circular Beams on Elastic Foundations, by Enrico Volterra. (52—A-16)

On the Application of the Impedance Method to Continuous Systems, by P. F. Chenea. (52—A-28)

On an Iterative Method for Nonlinear Vibrations, by R. E. Roberson. (52—A-20)

Natural Frequencies of Twisted Cantilever Beams, by D. D. Rosard. (52—A-15)

An Analytical Theory of the Creep Deformation of Materials, by Yoh-Han Pao and Joseph Marin. (53—APM-3)

Influence of Viscous Effects on Impact Tubes, by C. W. Hurd, K. P. Chesky, and A. H. Shapiro. (53—APM-10)

Axisymmetric Flexural Temperature Stresses in Circular Plates, by J. E. Goldberg. (53—APM-5)

Transient Thermal Stresses in Slabs and Circular Pressure Vessels, by M. P. Heisler. (53—APM-8)

The Shearing of a Rectangular Block Between Rough Plates, by J. W. Craggs. (53—APM-1)

The Torsion of Spiral Rods, by H. Okubo. (53—APM-2)

Reinforced Circular Holes in Bending With Shear, by S. R. Heller, Jr. (53—APM-9)

Some New Types of Orthotropic Plates Laminated of Orthotropic Material, by C. B. Smith. (53—APM-6)

High-Temperature Compression Testing of Graphite, by Leon Green, Jr. (53—APM-4)

DISCUSSION

On previously published papers by J. E. Brock; H. J. Fletcher and C. J. Thorne; C. A. Gongwer; L. S. Jacobsen; M. K. Huang and H. D. Conway; E. Sternberg and F. Rosenthal; D. S. Wood; M. H. L. Wu; W. F. Z. Lee and Edward Saibel; Yoh-Han Pao and Joseph Marin; and A. E. Abramson.

BOOK REVIEWS

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Measuring Transient Temperatures

COMMENT BY JAMES E. BROCK[1]

It is obvious that the thermocouples and measuring system described in this paper[2] were intended primarily for recording temperatures occurring at or near to the bore surfaces of gun barrels. Those who have had experience in temperature measurements in gun barrels know how difficult it is to construct thermocouples that will withstand the extreme pressure stresses encountered, and at the same time have quick enough response characteristics to measure accurately the steep front temperature transients that occur. The author is to be congratulated in having developed a thermocouple that gives dependable results under such extreme conditions.

The choice of metals for the thermocouples is good and a satisfactory method of forming the junction has been found. Attention is directed to the clever use of the oxide coating on the nickel wire for electrical insulation, and to the manner of assembling the thermocouple to give it mechanical strength. When a thermocouple temperature probe of the kind described in this paper is inserted in the wall of the gun tube, some disturbance of the heat-flow pattern is inevitable and the recorded temperatures can be in considerable error.[3] The assumption that the heat flow is only in a radial direction from the bore surface in gun tubes has never been verified by experiment. It is therefore necessary to evaluate carefully any data secured with the thermocouple. Considerations of this nature might cast some doubt upon the validity of the conclusion regarding the 1 deg F temperature differential between the true bore surface temperature and the value as measured with this thermocouple.

One could wish for more information about the measuring and recording system, especially about its sensitivity, frequency-response characteristics, and how it was calibrated so that the oscillogram amplitude could be translated to temperature. It would seem particularly desirable to have the measuring system sensibly linear in frequency response to frequencies several times greater than the apparent frequency of the transient wave front being recorded.

COMMENT BY R. B. DILLAWAY[4]

The paper gives evidence of a very thorough approach to the problem of measuring transient temperatures by a sensitive yet rather rugged thermocouple.

The author suggests that the instrument may be considered for measuring any rapid temperature variations. An attempt to test this gage for gas-dynamic applications by subjecting it to transient conditions through normal shock fronts gave negative results. It was concluded that the failure of the gage to show adequate response apparently results from the unfavorable ratio of heat conduction within the gage body as compared to the rather low rate of heat transfer to the measuring surface from the gaseous medium. While this leads to a true picture in the transient surface-temperature measurements, as described in the paper, it does not seem to encourage the use of the thermocouple for direct gas-dynamic measurements of the fluid medium itself. This is well supported by the order of magnitude of temperatures as found by the author in his measurement of gun-barrel temperatures as shown in Fig. 13 of the paper.

COMMENT BY V. PASCHKIS[5]

The technique described by the author is very interesting indeed. The writer wonders, however, if the statement that the thermocouple is "suited to measure metal-surface temperatures" is not too general. It would seem that a reliable temperature measurement can be obtained only in an arrangement similar to the author's Fig. 11. It would not be applicable to the case where the couple cannot penetrate the wall, one of which surfaces is to be observed. If the temperature rise of the surface is due to friction, the device would be unusable because the thin layer of plating soon would be scraped off, and because the plated surface does not have necessarily the same coefficient of friction as the surface which is to be investigated. In addition, it would seem that the couple is unusable or subject to major errors, as yet unexplored, if the "specimen wall" were made of a material having a conductivity significantly different from that of the couple.

Finally, an error should be mentioned which would occur even in the arrangement and under conditions as used by the author. The temperature of the surface will be measured accurately only if the boundary conductance (sometimes referred to as the coefficient of heat transfer; Btu/sq ft, hr, F) is the same for the couple and for the specimen. Not only emissivity, but also differences in surface roughness would change the boundary conductance and thus enter the picture.

The author states in his conclusions, "Although this thermocouple is particularly suited to measurement of metal-surface temperatures, its rapid response makes it worthy of consideration for any application where a rapid temperature variation is to be measured." Since the couple obviously is not fit for measuring temperatures of nonmetallic surfaces (differences in conductivity and diffusivity) or of temperatures within a metallic body (contact resistance between the couple and the metal; welding would destroy the plating), what applications does the author have in mind?

In view of these difficulties, attention should be drawn to the possibility of measuring temperatures inside the specimen and using computation to extrapolate to the surface. Such extrapolation can be carried out reasonably simply by means of analog computers or modern computational techniques.

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[1] Associate Professor of Mechanical Engineering, Purdue University, Lafayette, Ind.

[2] "A Special Thermocouple for Measuring Transient Temperatures," by David Bendersky, MECHANICAL ENGINEERING, vol. 75, February, 1953, pp. 117–121.

[3] "Mathematical Determination of Transient Temperatures in Solids," by Eugene Isaacsen, J. O. Gold, and Theodore Singer, Institute of Mathematics and Mechanics of New York University, IMM-NYU 164-CL-HV-29.

[4] Instructor in Mechanical Engineering, University of Illinois, Urbana, Ill. Jun. ASME.

[5] Technical Director, Heat and Mass Flow Analyzer Laboratory, Department of Mechanical Engineering, Columbia University, New York, N. Y. Mem. ASME.

AUTHOR'S CLOSURE

The helpful remarks of Professor Brock, Mr. Dillaway, and Mr. Paschkis are sincerely appreciated. Care was taken in the selection of the thermocouple materials and geometry to minimize disturbances mentioned by Dr. Brock. It is agreed that the answer to the question of whether heat flow from the bore surface of gun tubes is only radial has not been firmly established. However, data collected to date indicate in most cases no significant temperature gradient exists over the small exposed surface (0.006 sq. in.) of the thermocouple. It therefore seems reasonable to assume that the principal direction of heat flow is radial, at least through the one micron layer.

From the standpoint of response, the limiting recording equipment is the amplifier. The response of the preamplifier is flat up to about 30 kc, which is eight to ten times higher than the phenomenon being measured.

The author agrees with Mr. Dillaway that this thermocouple should not be used for measuring transient gas temperatures because of the relatively high-heat capacity of the probe. Tests conducted since the paper was written, in which the thermocouple was suddenly exposed to molten metal at known temperature, showed similar unsatisfactory results.

The author disagrees with Dr. Paschkis that this type of thermocouple would not be applicable to cases where it could not penetrate the wall. With proper care in the preparation of the blind hole, the end of the thermocouple could satisfactorily be pressed into contact with the bottom of the hole. A thin gold foil could be used to insure good thermal contact. The advantage of this thermocouple as compared with welding two thermocouple wires to the hole bottom would be the minimum disturbance of the temperatures at the point of measurement.

The effect of emissivity and surface roughness upon the surface temperature will depend upon the particular application. For our investigations, transfer of heat by radiation is negligibly small so that no great care was taken to make the emissivity of the thermocouple equal to that of the wall specimen; however, the surface roughness of the thermocouple is essentially equal to that of the walls we are investigating.

Dr. Paschkis points out that this thermocouple could not be used in walls having conductivity significantly different from that of the couple. This was covered by the author in the statement, "To avoid disturbing the normal flow of heat through the wall, the metals used in the thermocouple should have thermal properties as close to that of the wall material as possible."

Extrapolation to determine transient-temperature histories of an exposed wall surface based upon temperatures measured within the wall has been attempted by a number of investigators with generally unsatisfactory results. This is due to the insensitivity of the temperatures even a short distance from a surface undergoing a rapid temperature fluctuation, as was shown in Fig. 13 of the published paper (Fig. 14 in the preprint).

D. BENDERSKY.[6]

[6] Project Engineer, Engineering Division Midwest Research Institute, Kansas City, Mo

Cavitation-Laboratory Testing Equipment

COMMENT BY J. B. HOLT[7]

The writer visited the new cavitation laboratory[8] of the Dominion Engineering Company, Ltd., and was impressed with the many automatic metering devices and the time and labor that the staff saves during the running of a test. Of course, the greater the number of automatic devices placed on any equipment so much greater will be the number of points of possible trouble, requiring more maintenance work. With everything in proper working order the laboratory should allow tests to be conducted in a minimum of time.

[7] Assistant Hydraulic Engineer, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

[8] "Cavitation Laboratory for Hydraulic Turbines," by Hans Ulmann and R. S. Sproule, MECHANICAL ENGINEERING, vol. 75, March, 1953, pp. 194–198.

COMMENT BY W. J. RHEINGANS[9]

The cavitation laboratory described by the authors is certainly as complete and modern as could be built at the present time. It has many excellent features, and appears to be capable of making accurate measurements of the various quantities. The ability to repeat test points within close tolerances is of utmost importance in a testing laboratory of this type, and this is possible only with well-designed test equipment.

During the presentation of the paper the authors described some recent tests they had made in this laboratory and remarked about the difficulty of obtaining a definite cavitation break-off point, by plotting either efficiency, power, or discharge against the cavitation sigma values. This same difficulty is prevalent in nearly all cavitation laboratories, and up to the present time no satisfactory solution has been presented. It is probable that the application of either oral or visual methods for determining the inception of cavitation may be of some help in this connection.

The authors also remarked about the rather disturbing fact that the value of sigma at the incipient cavitation point for a given model runner seemed to decrease with an increase in test head. This means that as the head increased the cavitation characteristics of the runner seemed to improve. A similar phenomenon has been observed in other cavitation laboratories. One explanation is that the scale effect which distorts the element of time with varying velocities due to varying heads, influences the formation of cavitation. Probably the laboratory described by the authors will make it possible to solve this problem.

It is noted that the cavitation tests are being made in an open-flume setting. It is quite possible that both the efficiency of the model turbine and its cavitation characteristics will be affected materially when tested with various spiral-casing settings.

[9] Manager, Hydraulics Section, Power Department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. Mem. ASME.

COMMENT BY R. W. WILLI[10]

Since the installation of the cavitation laboratory by the writer's company in 1938, the possible effect of deaeration of the circulating water on test results has been given much consideration. In principle this flume resembles that described in the paper, but does not include a resorber. It was felt, therefore, that test values of (critical) sigma might err on the side of danger.

Extensive tests have been made, therefore, under similar conditions of gate, phi, and unit power, first determining the critical sigma using a high head and a high-pressure level within the closed system, then with a low head and low-pressure level. Variations have included tests immediately after charging the system with fresh water, and at the end of a day's operation with a vacuum pump continuously removing any air from the tank into which the draft tube discharges. The same water has been used for several weeks at a time, during which

[10] Chief Engineer, Southwark Operation, Baldwin-Lima-Hamilton Corporation, Eddystone, Pa. Mem. ASME.

the pressure at discharge from the runner has varied from atmospheric to 29 in. hg. Such variables have failed to show any influence on the sigma break. It has been found, however, that air deliberately bled into the turbine through a center bore in the main shaft will elevate the sigma break.

The performance of prototype turbines in the field, after a reasonable period of service, does not indicate a sigma break unlike the model. This has been checked both by observation of pitting and by deliberately operating the prototypes at their critical sigmas. Sometimes this can be done by overloading units which are subjected to maximum heads considerably above their rated heads. Normally, on such units, gate opening is limited for the higher heads to prevent continuous overloading of the generators.

Having previously standardized on 16-in. model equipment the continuation of this size in a new laboratory may be justified. The 11-in. model size adopted by the writer's company has proved most satisfactory from the standpoint of facility of handling model parts. Changeover time and operating costs are minimized to the benefit of over-all laboratory output of data. Formal field acceptance tests have substantiated the reliability and accuracy of the 11-in. model.

AUTHORS' CLOSURE

The comments by the three discussers are appreciated.

Since presentation of the paper the engineers of the laboratory have installed a transparent section of "Lucite" in the draft tube which permits visual observation of flow conditions through the runner from the wicket-gate outlet into the draft tube elbow. This has been done in a preliminary way with various Francis type runners and some rather startling facts have been disclosed. We feel at present that the investigation of the cavitation phenomenon on hydraulic turbines is beginning only and that many existing ideas and interpretation of what goes on will need revision.

Tests have shown that cavitation of different types occurs at several places of the same runner at different operating conditions and that the magnitude and characteristics of the cavitation change with varying sigma, speed, and gate opening. This probably explains the gradual drop of runner performance versus sigma and the difficulty of finding a definite cavitation break-off point or critical sigma. The effect of head has not been investigated in the laboratory and Mr. Rheingan's remarks regarding the relation between head and critical sigma of the runner seem to be based on a misunderstanding. In view of the changing cavitation characteristics at different operating conditions and because of limitations of the laboratory installation it would seem rather difficult to investigate thoroughly the effect of turbine size and operating head.

HANS ULMANN.[11]
R. S. SPROULE.[12]

[11] Chief Engineer, Industrial Division, Dominion Engineering Company, Ltd., Montreal, Canada. Mem. ASME.

[12] Assistant Manager, Sales, Hydraulic Division, Dominion Engineering Company, Ltd., Montreal, Canada.

Automatic Machinery[13]

COMMENT BY LILLIAN M. GILBRETH[14]

As engineers, the pioneers in scientific management were pledged to use the resources of nature and of human nature for the benefit of mankind. A reading of the things they wrote proves that they concerned themselves with human beings. This in spite of the fact that they wrote primarily for engineers, in the shop vernacular of their day.

Especially in the field of motion study and work simplification, the emphasis has always been, and is today, on the worker on the job. It is essential that he co-operate in the studies which record, conserve, and develop his skill and enable him to contribute to work standards. He profits by the opportunity to learn how to develop his capacities and to utilize his highest skills. Through this co-operation, progress in manpower utilization has been made. Waste has been eliminated. Methods have been developed which take account of likenesses and of individual differences between people. The increasing emphasis on encouraging suggestions or proposals for improvements indicates not only a keen interest in motivation but a realization that without participation of every member of a work team the results are unsatisfactory.

The liabilities as well as the assets of automation have been realized all through the years. Changes have invariably been postponed, where the principles of scientific management have been adequately used, until workers who could have been displaced have been satisfactorily provided for.

The engineer and his colleagues in the field of industrial management will not make man "only the equivalent of the machine." They aim to make the machine, like the tool, a means of extending the personality of the worker and to make his life richer and more satisfying. And they believe that their "solicitude for human values" is not a way of compensating for mechanizing men through their work but that it is the compelling reason why they keep steadfastly at their job of eliminating waste of human effort, through the years.

The "Ten Years' Progress in Management," report of the Management Division, we believe, proves this.

COMMENT BY LEV A. TROFIMOV[15]

As engineers, it is our obligation to humanity to liberate it from hard labor. There is no other way to do this except by making a machine to do the hard work and assign the easy task of controlling it to a man. All my life I have been designing controls to make machines automatic. On several occasions I was told that my work was detrimental to the laboring people since it caused unemployment. I agreed that an automatic machine does create unemployment, but I emphatically denied that such work is detrimental to the laboring people. I sincerely feel that I have been doing my duty as an engineer.

The creation of more and more automatic machinery is a natural and unavoidable process, just as unavoidable as old age. Even if we had all agreed and made laws forbidding the inventions of new automatic machinery, we could not have stopped the process. We are now farther than halfway to the automatic factory.

How about unemployment? We admit that we are creating unemployment, but also we are creating new jobs necessary for manufacturing automatic machines. Furthermore, we engineers are discovering entirely new industries which we could not have discovered if it were not for the automatic machine. It is easy to show by statistics that the more automatic machinery we have the more jobs we create.

Let us take a less optimistic point of view in order to bring out the point I am trying to make. Assume that the industry cannot absorb the unemployment the automatic factory may create,

[13] "The Future of Automatic Machinery," by Norbert Wiener, MECHANICAL ENGINEERING, vol. 75, February, 1953, pp. 130–132.

[14] President, Gilbreth, Inc., Montclair, N. J. Fellow ASME.

[15] Vice-President, Speed Control Corporation, Wickliffe, Ohio.

even by reducing radically the hours in the working day. I believe that such a moment will arrive and it will be the blessing to humanity. I do not think it is up to the engineer to worry about it. It will be up to society to prepare nonproductive jobs for the unemployed. This transfer of a man from the hard work in the production shop to the much more pleasant nonproductive occupation in society is the manifestation of the liberation process. Some nonproductive jobs are teaching, recreation, and all kinds of services. My point is this: It is not fair to expect industry to absorb all the unemployment created by the automatic-factory era. This task must be at least divided between industry and society. The question is: Is society aware of it? Is there anybody who plans to do something about it?

Inasmuch as the effect always lags behind the cause, it is timely and proper for society to make plans now for what can be done with unemployment after the automatic factory has rightfully taken its place in industry.

COMMENT BY C. C. WAN[16]

The author's remarks on the future of automatic machinery should go a long way toward clearing away some of the misconception that exists in the minds of many that automatic devices will create undue competition to human workers. Although it is possible to duplicate certain simple functions of human beings by automatic devices, it would be extremely difficult to provide complete simulation of human behavior and human intelligence.

The example concerning the translation machine is particularly to the point. This discusser likes to cite his own experience with many technical articles translated by various organizations during the last war. These translations must have been done under great pressure, for they were so unintelligible that it was necessary to make a literal translation back to the original language to bring out the content of the intended argument. It is doubtful if a mechanical translating device can do a better job than these literal translations.

COMMENT BY RAYMOND H. WATSON[17]

The author states, "In general, the correspondence between speech and writing must go through an understanding of the meaning of the written or spoken language." The statement is technically true but in a practical sense its limitations can be circumvented within the scope of some common languages by use of what might be called sonic reading. This can be accomplished by spelling out words letter by letter. This method seems unbearably slow until it is realized that even a novice can absorb the meaning of the words more quickly than the letters can be pronounced. Even in verbal form this method is considerably faster than code telegraphy or code radio which are received in essentially the same manner and unconsciously translated from groups of letters to words, or even groups of words. Small ingenuity would be required to couple photoelectric pickup to the sound output for individual letters and to complete the reading machine for the blind.

The machine for the deaf apparently would be more complicated because of the necessity of tolerances in the matter of deviations from an unstandardized normal pronunciation of words. This is, of course, another way of stating that man does not possess a precise spoken language. Perhaps the development of the machine would encourage improved speech in an endeavor to use the machine. An apparent way to side-step the inherent disadvantages of machines pointed out by the author, would be for word sounds to actuate whole word elements which would type the correct sequence of letters. No simple way seems open to spell correctly two or more phonetically similar words of different spellings. Even this machine should rate as more than a rudimentary form, however, bulky as it might be.

Successful production of either of these imaginary machines would in no way tend to refute the author's admirable classification of the realms of thought possible for machines. Our machines still have no consciences, opinions, or prejudices; nor can they interpret thoughts.

[16] Project Engineer, Chance Vought Aircraft, Dallas, Texas. Jun. ASME.

[17] Mechanical Engineer, U. S. Engineers Office, Kansas City, Mo. Mem. ASME.

Large-Diameter Line Pipe

COMMENT BY MASON S. NOYES[18]

In the first part of the paper[19] the author states that the range of sizes of pipe goes up to 36 in. diam. It is understood from the author that the plates used were 6 ft in width. In making the largest sizes such as the 36-in., are one or two plates used in the circumference? That is, are the two plates welded together before forming the pipe, or is only one plate used?

COMMENT BY E. S. THEISS[20]

This is an excellent paper which indicates a number of applications of widespread interest. The writer was intrigued by the possibility of making unfired pressure vessels, particularly air receivers, from pipe of this manufacture. It would be simple to make cylindrical sections of desired length, and then weld to them dished heads of proper size, using steel meeting ASME Code requirements.

The author points out that his company has not produced receivers, but has manufactured a number of high-pressure vessels, such as are employed in chemical plants and gasoline refineries.

AUTHOR'S CLOSURE

Mr. Noyes inquires whether a single longitudinal weld or double weld would be required for 36-in. pipe. While it has not yet been fabricated as a production item, the intent is to make 36-in. pipe with a single longitudinal weld. Pipe 30-in. OD is in common use by the industry and is made with a single longitudinal weld using plates approximately 93 in. wide.

The author appreciates the comments of Mr. Theiss and submits the following information regarding the use of pipe for ASME unfired pressure vessels. Unfired pressure vessels have been made of pipe meeting ASME Code requirements. However, since the ASME Code design basis is on ultimate strength rather than yield strength, the higher yield strength obtained by cold expansion is not considered in the design of the vessel and evidences itself only when the user considers the safety factor he has on yield strength. The ASME Code limits the use of any type of pipe for pressure vessels to 30 in. maximum diam. Flash-resistance welded pipe, which was the product discussed in the paper, may be used for ASME Code unfired pressure vessels and is covered by Case No. 1124-1.

W. C. HOPPE.[21]

[18] Production Welding Department, Tube Turns, Inc., Louisville, Ky. Mem. ASME.

[19] "Large-Diameter Line Pipe—Its Production and Some Applications," by W. C. Hoppe, MECHANICAL ENGINEERING, vol. 75, February 1953, pp. 114–116.

[20] Chief Engineer, Design, Production and Plant Maintenance, Engineering Division, Davey Compressor Company, Kent, Ohio. Vice-President, ASME.

[21] Tubular Products Engineer, A. O. Smith Corporation, Milwaukee, Wis.

Forging-Press Developments

COMMENT BY E. V. CRANE[22]

In discussing this paper,[23] the writer would like to step out of his company connection, if that is possible, and assume the role of a mere member of one of this country's leading technical societies.

The writer is impressed by the fact that such radically different conclusions can be reached by engineers working to common specifications and with a reasonably common background of engineering knowledge. Differences of opinion of course are fortunate and often very worth while. The value of getting different points of view into this tremendous program was expressed early in the discussion of it.

Because five engineering groups are participating, it is proper to recognize three general points of view: (1) European thinking, represented by Loewy's Hydropress, Inc., is influenced by accomplished foreign design practice and manufacturing usage. The German 15,000-ton (metric) presses and the 30,000-ton press furnish background for the thinking. It is further influenced by relative labor costs and the high cost of oil in Germany. (2) American steel-mill thinking, represented by the outstanding suppliers to that industry, Mesta and United. This thinking also has been restricted largely to water, accumulator open-rod presses which have been built up to 14,000 and 18,000-ton sizes. (3) American stamping-industry thinking, represented by Bliss and Baldwin-Lima-Hamilton, has swung rather rapidly to closed-circuit oil systems and, in general, to housing-type presses. The press-building companies produce quantities of presses in the smaller sizes according to these principles, but have built some in the range of 5000, 7000, 12,000 and 18,000 tons capacity, mostly open-rod structures.

The spirit of competition must be recognized. It has been back of much real progress even though it is at odds with the engineering societies in the matter of free exchange of technical data. The extent to which each should prevail in a situation of this sort is debatable.

In this discussion of a specific group of forging presses, debate has begun with manufacturing and shipping facilities. It has progressed to tension members, frame structures, sway stability, effective use of metal, accessibility, maintenance, operating efficiency and assembly problems. These debates raging behind the scenes get down to a matter of relative values. At this stage all of the designs should be pretty well frozen.

There seems to be no real question but that each of the competing units will operate, and satisfactorily.

For a program of such magnitude it seems to have been well-handled.

[22] Chief Special Development Engineer, E. W. Bliss Company, Canton, Ohio. Mem. ASME.

[23] "World's Largest Forging Press," by F. T. Morrison and R. G. Sturm, MECHANICAL ENGINEERING, vol. 75, March, 1953, pp. 191–193, 204.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Gas Turbines

DIE GASTURBINE. By J. Kruschik. Springer-Verlag, Vienna, Austria, 1952. Cloth, 6 × 9 in., 153 figs., 67 tables, 9 charts, bibliography, index, xi and 469 pp., $15.

REVIEWED BY C. RICHARD SODERBERG[1]

THE gas turbine has developed rapidly during the last decade, and there has already emerged a vast and unwieldy literature on the subject. It is not easy for students to sift out the contributions of enduring value from those of only transient significance. Much of the material is written in the half light of partial military secrecy, and some of the really significant contributions are not revealed at all.

The author of the present book has made an honest effort to present the significant aspects of the new prime mover as seen from a survey of the available literature. The extensive literature index is based on a selection which in most instances appears fortunate. In spite of the fact that the book is necessarily silent on many of the important accomplishments related to the subject, particularly in the United States, it appears worthy to be listed among those which are likely to have enduring value.

Without losing himself in design details, the author succeeds in covering an amazingly wide field. After a short historical introduction, he presents a perspective of the major types of cycles. There follows a more detailed presentation of the thermodynamics of gas-turbine cycles, giving an excellent discussion of the major cycle parameters and their significance. After a review of the information on properties of air and products of combustion, there follows a brief description of the major components of gas-turbine plants. The information is hardly detailed enough to provide a basis for detail design, but much of it is of fundamental value. Unfortunately, some of it is now out of date. This applies particularly to the information on American developments. The following chapter on the different cycle combinations, particularly their properties with respect to part-load performance, seems of great value. There is a short and concise chapter on high-temperature materials. The chapters on the closed and semi-closed cycles complete the first half of the book.

The remainder of the book concerns itself with the problems of applications of the new prime mover to power generation, industrial applications, ships, locomotives, and motor cars. The last three chapters cover applications to aircraft propulsion.

The book is notable for its mature approach to the many aspects of evaluating the new prime mover. Its scope is too broad to permit entering into design details of the various components, but it succeeds in bringing out many pertinent facts.

The American reader may find it difficult to avoid a sense of impatience over the fact that there seem to be relatively few American accomplishments worthy of note. This is particularly true of the

[1] Head of the Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. Fellow ASME.

chapter on aircraft propulsion, which is devoted chiefly to English developments. It is worth remembering, however, that this is the picture which unfolds from a survey of unclassified literature and may perhaps provide a measure of comfort to those who know better.

The value of the book lies in its synthesis of essential fundamental facts which are of value even when this or that design has become obsolete. It is difficult, indeed, to avoid regretting that the author did not in many instances have access to more up-to-date information.

Wheels for Railroads

RADREIFEN, RADSCHEIBEN, UND VOLLRÄDER. By O. H. Lehmann. Verlag Stahleisen M.B.H., Düsseldorf, Germany, 1952. Cloth, 6 × 9 in., 55 figs., bibliography, name and subject indexes, 94 pp., 14.50 Dm.

REVIEWED BY W. TRINKS[2]

THIS book deals with the production of wheels (solid as well as composite) for railroads. It begins with ingots and their subdivision, and ends with testing of the finished product. On 24 pages the forging and rolling of tires is described. In 13 pages the forging and rolling of hubs and of solid wheels are explained and illustrated. A few pages deal with heat-treatment.

Although this book was written to describe and explain the production of rolling material used by the German railroads, almost all of the described processes can be applied to Usayan (American) railroad wheels and tires. In fact, several processes that were originated and developed in the United States are described and illustrated in detail. Some space is devoted to description and illustration of furnaces in which the ingots and blanks are heated. It is interesting to note that German continuous furnaces are successfully side-fired, whereas sidefiring is almost a heresy in the United States. The book contains many good line drawings and sectional drawings.

Almost all of the material contained in this book has previously been published in scientific and trade papers; however, the reviewer knows of no book in the English language that covers the subject under discussion.

Those railroad engineers and makers of wheels who can read German will enjoy the book. The reviewer did just that.

[2] Professor Emeritus, Carnegie Institute of Technology, Pittsburgh, Pa. Fellow ASME.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

Books Received in Library

ASTM SPECIFICATIONS FOR STEEL, PIPING MATERIALS. Prepared by ASTM Committee A-1 on Steel. American Society for Testing Materials, Philadelphia, Pa., 1952. 383 pp., 6 × 9 in., paper, $3.75. This compilation contains in their latest approved form the 56 ASTM specifications for carbon-steel and alloy-steel pipe and tubing, including stainless. The major categories into which the specifications are grouped are as follows: pipe, boiler, superheater, and miscellaneous tubes; still tubes; heat-exchanger and condenser tubes; castings; forgings and welding fittings; bolting; grain size. Two special grain-size charts for classification of steels are included. Sixteen emergency alternate provisions applying to specifications in this compilation are printed in a separate section at the back of the book.

ELEMENTS OF PROPELLER AND HELICOPTER AERODYNAMICS. By Daniel O. Dommasch. Pitman Publishing Corporation, New York, N. Y., 1953. 178 pp., 6¼ × 9½ in., bound, $4.50. Considering helicopter aerodynamics as an extension of propeller theory, the author has combined the two for a single course. The first half of the book consists of three chapters on basic principles and definitions, blade-element theories, and propeller characteristics. The other three chapters are more specialized treatments: axial flow through the helicopter rotor; the helicopter in forward flight; and helicopter stability and control.

ENGINEERING MANUFACTURING METHODS. By Gilbert S. Schaller. McGraw-Hill Book Company, Inc., New York, N. Y., 1953. 613 pp., 6½ × 9½ in., bound, $7. This text is intended to provide the engineering student with a broad coverage in the fundamentals of founding, machining, welding, hot and cold shaping, thermal treatment, and engineering materials. Some attention is given to light metals and plastics in discussing materials, and special emphasis is placed on recent technological developments in dealing with methods. The aim is to give an understanding of the potentialities of various methods, as a basis for selection, in producing quality products at satisfactory costs. In addition to literature references there is also a list of motion pictures and film strips on pertinent subjects.

ENGINEERING VALUATION AND DEPRECIATION. By Anson Marston, Robley Winfrey and Jean C. Hempstead. McGraw-Hill Book Company, Inc., New York, N. Y., second edition, 1953. 508 pp., 6¼ × 9¼ in., bound, $8. This text deals with concepts and procedures involved in the appraisal of industrial, commercial, utility, and natural-resource properties, illustrating their application by specific examples. There are complete and detailed discussions on depreciation, service lives, and limited-life enterprises, and a comparison of depreciation methods when applied to property groups as distinguished from single units. Controlling court decisions for valuation practice are cited. The extensive revision includes a new chapter on fair rate of return.

EQUIPMENT FOR THE THERMAL TREATMENT OF NON-FERROUS METALS AND ALLOYS. (Monograph and Report Series, No. 14.) The Institute of Metals, London, England, 1953. 104 pp., 8¾ × 11¼ in., bound, $2.50. The seven papers in this symposium deal with the following topics: electric furnaces; gas equipment for heat-treatment; batch and continuous annealing of copper and copper alloys; bright annealing of nickel and its alloys; batch heat-treatment of light alloys; flash annealing of light alloys; and continuous heat-treatment of aluminum alloys of the Duralumin type. There is a general subject index covering all the papers.

DIE HEBEZEUGE. By Hellmut Ernst. Friedr. Vieweg & Sohn, Braunschweig, Germany, second edition. 8 × 10¾ in., bound. Volume 1, Grundlagen und Bauteile. 304 pp., 32.24 Dm. Volume 2, Winden und Krane. 302 pp., 38.80 Dm. Volume 1 of this work on hoisting machinery covers fundamentals of design and construction of crane frames, cable drives, chain drives, simple load-lifting devices, shafts and bearings, brakes, couplings, electrical equipment, and other component elements. Volume 2 deals with the standard and most-used hoisting equipment: cable winches, grabs and grab winches, traveling cranes, electric hoists, wall-bracket and pillar cranes, self-propelling swinging cranes, rail and caterpillar-track cranes. Planning, erection, and operation of cranes are also considered. Volume 3 will deal with special installations.

INDUSTRIAL BRAZING. By H. R. Brooker and E. V. Beatson. Iliffe & Sons, Ltd., London, England. (Distributed in U. S. by British Book Centre, Inc., New York, N. Y.), 1953. 344 pp., 5¾ × 8¾ in., bound, $7.50. Following introductory chapters on the origins and principles of brazing, methods of heating, materials, and the design of brazed joints, this comprehensive work discusses in detail the various brazing methods: torch, furnace, induction, resistance, salt bath, and dip. Also treated are aluminum brazing by the furnace, and flux dip methods, and special applications such as brazing cemented carbides, and metal-to-ceramic brazed joints. The final chapter deals with the selection of processes and with inspection.

MANUAL FOR THE DESIGN OF FERROUS AND NON-FERROUS PRESSURE VESSELS AND TANKS. By Karl Siemon. Edward Brothers, Inc., Ann Arbor, Mich., fourth edition, 1952. 284 pp., 5½ × 8½ in., bound, $3.85. Part 1 discusses properties and fabricating characteristics of the principal metals used, both ferrous and nonferrous. Part 2 provides a de-

tailed treatment of the design of pressure vessels and tanks. Revisions and minor corrections bring the manual into line with the established codes for power boilers and unfired pressure vessels and with current practice. The arrangement is similar to the earlier editions, with a technical data section at the back. A brief supplement on hoop design is appended.

OXIDATION OF METALS AND ALLOYS. By O. Kubaschewski and B. E. Hopkins. Academic Press Inc., New York, N. Y., 1953. 239 pp., $6\frac{1}{2} \times 10$ in., bound, $6. This detailed work, designed to bridge the gap between theoretical study and practical application, provides an appraisal of the state of research in the field and gives an account of the existing ideas on the subject. It includes the examination of oxidation products, methods of measurement, protection of surfaces, and much fundamental data. The list of references includes over 500 citations.

PHOTOMETRY. By John W. T. Walsh. Constable and Company, Ltd., London, England. (Distributed in U. S. by The Macmillan Company, New York, N. Y.), second edition, 1953. 544 pp., $6\frac{1}{2} \times 9\frac{1}{2}$ in., bound, $12.75. A comprehensive work on the techniques of light measurement including spectrophotometry, and colorimetry as a method of heterochromatic photometry. This complete revision of the 1926 edition describes fully the photoelectric cell characteristics pertinent to photometric measurements and emphasizes the widespread use of photoelectric methods. It discusses the C.I.E. (Commission Internationale de l'Eclairage) system of color specification, and the work done on a primary standard of light. Nomenclature reflects current British usage. Comprehensive bibliographies and various colorimetric and photometric tables are included.

PHYSICAL SIMILARITY AND DIMENSIONAL ANALYSIS. By W. J. Duncan. Edward Arnold and Company, London (distributed in U. S. by Longmans, Green and Company, Inc., New York, N. Y.), 1953. 156 p., $8\frac{3}{4} \times 5\frac{3}{4}$ in., bound, $5.75. The point of view adopted in this book is that dimensional analysis is a convenient technique for obtaining the quantitative conditions for similarity in behavior of a family of similar physical systems and the consequences of this similarity in behavior. The author first discusses units and measures, geometric and kinematic similarity, and similarity in Newtonian dynamics. Then comes an introduction to dimensional analysis followed by more detailed treatment under the headings of fluid motion, heat, and electromagnetism. There is a special chapter on the use of nondimensional coefficients in engineering design—propellers, pumps, and aircraft performance, and some treatment of special problems such as the deflection of beams.

SMALL PARTICLE STATISTICS. By G. Herdan. Elsevier Publishing Company, Houston, Texas, 1953. 520 pp., $6 \times 9\frac{1}{4}$ in., bound, $12. This book discusses small-particle statistics as mathematical procedures for the solution of problems met by research workers in dealing with particle sizes between 10 and 10^{-6} centimeters. Problems considered include the measurement of particle size, sampling procedures, graphical representation, and bi and multivariate distributions, one of whose variables is particle size. Also treated are the changes in particle-size distribution through crushing, grinding, flocculation, and demulsification. A separate section is devoted to a critical review of methods of determining size distribution and surface area. Applications to a wide range of industries and techniques are indicated.

STAUCHEN UND PRESSEN. By J. Billigmann. Carl Hanser Verlag, Münich, Germany, 1953. 574 pp., $6 \times 8\frac{1}{2}$ in., bound, 28.50 Dm. A handbook on the plastic cold and hot-forming of steel and nonferrous metals for the mass production of small and medium parts. Emphasis is on pressing and upsetting. The book contains chapters on raw materials, operating methods and machinery, furnaces and heating equipment, tools, applications of pressing and upsetting, defects, subsequent treatment of parts, economic problems and costs. Patents, standards, and literature references are listed, there are over 500 sketches and illustrations.

STRÖMUNGSMASCHINEN. By Carl Pfleiderer. Springer-Verlag, Berlin, Germany, 1952. 383 pp., $6\frac{1}{2} \times 9\frac{1}{4}$ in., bound, 36 Dm. An advanced treatment of gas and hydraulic turbines, centrifugal pumps, compressors, etc., intended to cover those principles common to all types of turbomachinery, either prime movers or driven machines. The several sections deal respectively with the following: fluid mechanics of runners; design and examples of operation of runners; characteristics of single-stage machines; clearance loss and axle thrust, guiding devices and passages; special aspects of axial runners; characteristics of single and multistage compressors and turbines.

STRUCTURAL PRINCIPLES AND DATA. (Handbook of Aeronautics, No. 1.) Published under the authority of the Council of the Royal Aeronautical Society. Pitman Publishing Corporation, New York, N. Y., fourth edition, 1952. 322 pp., $6\frac{1}{4} \times 10$ in., bound, $8.50. This book is the first of a series of volumes comprising a new edition of Pitman's "Handbook of Aeronautics," now considerably out-of-date. In Part 1, on "structural airworthiness," the emphasis is on the estimation of loading systems acting on the airplane structure arising from the design considerations. Part 2 is a presentation of the parts of the theory of structures which are of particular interest in the design and analysis of stressed skin structures, dealing with stress-strain relations, buckling, instability, etc. An extensive bibliography is appended.

SYNCHROS, SELF-SYNCHRONOUS DEVICES AND ELECTRICAL SERVO-MECHANISMS. By Leonard R. Crow. Scientific Book Publishing Co., Vincennes, Indiana, 1953. 222 pp., $5\frac{3}{4} \times 8\frac{3}{4}$ in., bound, $4.20. The purpose of this book is to contribute a broad understanding of the fundamental principles underlying the functional operating theory as well as the effective application of synchros and allied self-synchronous electrical mechanisms. Structural features are described in detail necessary for proper understanding of function and application of types and forms of these devices.

TEXTILE FIBERS, YARNS, AND FABRICS. A Comparative Survey of Their Behavior With Special Reference to Wool. By Ernest R. Kaswell. Reinhold Publishing Corporation, New York, N. Y., 1953. 552 pp., $9\frac{1}{4} \times 6\frac{1}{2}$ in., bound, $11. This is an annotated and interpretive bibliography of textile-fiber research constituting a survey of over 400 authoritative references. Divided into two sections, Part A discusses such inherent properties of fabrics as density, refractive index, tenacity, rupture elongation, elastic modulus, and resistance to chemicals. Part B discusses form factors such as yarn denier, density, twist, and diameter, also fabric weight, thickness, thread count, and weave. The influence of properties and factors on fabric luster, crease retention, and abrasion resistance is considered; some conclusions are drawn as to the relative merits of fibers and fabric structures, with special emphasis on the position of wool.

THEORETICAL AERODYNAMICS. By L. M. Milne-Thomson. D. Van Nostrand Company, Inc., New York, N. Y., second edition, 1952. 414 pp., $10 \times 6\frac{3}{4}$ in., bound, $10. Based on lectures given at the Royal Naval College, this book discusses the assumptions used in studying the airflow around aircraft. It brings these assumptions to explicit statements and then examines what can be deduced from them. After preliminary discussion the theory of two-dimensional airfoils is considered. Three-dimensional airfoils, the effect of compressibility of air in subsonic and supersonic flow, and the aircraft as a whole are subsequently considered; apart from the removal of some defects, the revision consists of the addition of a new chapter on conical flow.

THEORY OF HOMOGENEOUS TURBULENCE. By G. K. Batchelor. Cambridge University Press, New York, N. Y., 1953. 197 pp., $8\frac{3}{4} \times 5\frac{3}{4}$, bound, $5. This is a systematic account of the present state of knowledge in the field. After a brief review of the major contributions of the last fifteen years, the following topics are discussed: mathematical representation of the field of turbulence; kinematics of homogeneous turbulence; linear problems; dynamics of decay; the universal equilibrium theory; decay of energy-containing eddies, and the probability distribution of $u(x)$. A bibliography of research through 1952 is included.

THERMODYNAMIQUE. By J. Rocard. Masson et Cie, Paris, France, 1952. 550 pp., $7 \times 9\frac{3}{4}$ in., bound, 4150 fr. This comprehensive work starts with a basic treatment of classical thermodynamics, continues with a discussion of the thermodynamic properties of gases and liquids, and then takes up the practical aspects of the thermodynamics of heat engines, refrigeration, etc., including the possibilities of nuclear energy. Subsequent sections are devoted to the kinetic theory of gases, to irreversible phenomena, and to statistical mechanics as applied to thermodynamics. There is also a short section on radiation and stellar thermodynamics. The book is intended both as a text and as a reference work for engineers.

U. S. NATIONAL CONGRESS OF APPLIED MECHANICS, PROCEEDINGS OF THE FIRST. The American Society of Mechanical Engineers, 29 West 39th Street, New York, N. Y., 1952. 965 pp., $11\frac{1}{4} \times 9$ in., bound, $20. The first of a series of congresses to be held at approximately four-year intervals, this volume contains 125 papers on a wide range of topics arranged in four major groupings: general methods, dynamics, vibrations, impact; elasticity, photoelasticity, plate theory, elastic instability; plasticity, behavior of materials, failure; fluid flow, aerodynamics, heat. Five general lectures are also included dealing respectively with elastic stability, creep in metals and polymers, fluid-flow theory, high-speed aerodynamics, and the relationship of heat transfer to mechanics and other branches of science.

WIND-TUNNEL TECHNIQUE. By R. C. Pankhurst and D. W. Holder. Sir Isaac Pitman & Sons, Ltd., London, England, 1952. 702 pp., $6 \times 8\frac{3}{4}$ in., bound, 57s, 6d. A systematic account of the experimental methods employed in both low and high-speed wind tunnels. Major topics include wind-tunnel design, flow visualization methods, measurement of fluid velocity, tunnel interference effects, model construction, and the reduction of observations. Auxiliary apparatus and experimental analogies are discussed, and there is a separate chapter on special measurements such as stability and control, turbulence, and flutter. Chapter bibliographies are provided.

ASME NEWS

With Notes on the Engineering Profession

Rochester, N. Y.—World-Famous Industrial Center —to Be Scene of 1953 ASME Fall Meeting

Headquarters: Sheraton Hotel, October 5–7

ARRANGEMENTS are all but completed for the 1953 Fall Meeting of The American Society of Mechanical Engineers to be held at the Sheraton Hotel, Rochester, N. Y., Oct. 5–7, 1953.

Program Notes

About 20 technical sessions are scheduled which will be devoted to the presentation of more than 70 papers, symposiums, and panels in the engineering fields of fuels, management, instruments and regulators, machine design, materials handling, power, product engineering, education, metal processing, heat transfer, process industries, and safety.

"What are the specifications for an effective system of standard data?" is the topic selected for discussion at the Management Division panel. The Calvin W. Rice lecturer will be J. Foster Petree of London, England, the distinguished editor of *Engineering*. F. S. Blackall, jr., president ASME, will be the principal speaker at the President's Luncheon,

Rochester—City of Flowers

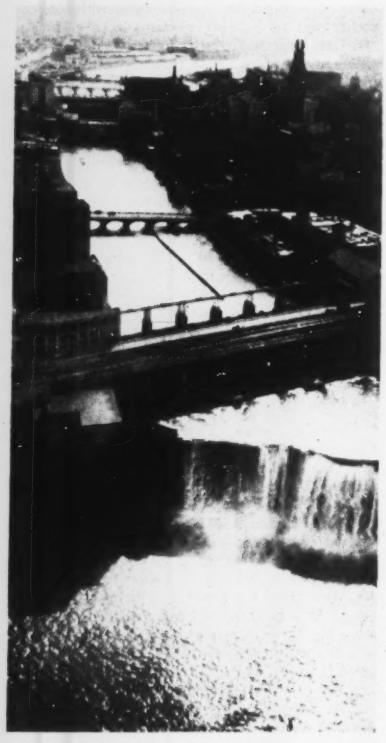
Rochester, situated at the mouth of the Genesee River on Lake Ontario, is, as the name implies, "Beautiful Valley." Gen-ne-see, named by the Iroquois Indians, extends some fifty miles south of the city, where the river plummets and thunders through a picturesque gorge, part of which has been preserved in Letchworth State Park.

The last three foaming falls may be readily observed as the river tumbles through the heart of the city. These falls provided abundant water power, which led to the early building of gristmills.

Gristmills fathers the city's first nickname—"flour city." The mills are gone now, but the city's floral displays cause it still to be called the "flower city." The flower season is perpetual, and is crowned annually in mid-May with a week-long Lilac Festival attracting thousands of visitors to view over 400 varieties in world-famous Highland Park.

Rochester is an important port on the Erie-Barge Canal, connecting Buffalo and the Western Great Lakes with New York City. As a Great Lakes port, it ranks high, handling about one-million freight tons, and 75,000 passengers annually. The city is readily accessible by air with 6000 planes flying in and out each year. Served by a number of trunk-line railroads, it is an important division of the main line of The New York Central System.

Visitors converging on Rochester from any direction may take advantage of the opportunity to see some of Western New York's interesting spots and scenic wonders. From the West and Southwest, Niagara Falls, The Chautauqua Institute, or the Allegany State Park might well provide an interesting side trip. Approaching through the Finger Lake Region, a stop at Watkins Glen, sport-car racing capital; or the "Rhine of America," in the Hammondsport-Naples area would prove interesting. Traveling through Corning, N. Y., the Corning Glass Center, museum of glassmaking since 1500 B.C., is a must. Eastern visitors will find the Catskills or the Adirondacks in scenic splendor at meeting time.



ROCHESTER, N. Y., SCENE OF THE 1953 ASME FALL MEETING WILL BE HELD OCT. 5–7

Once in Rochester, the Eastman House, memorial home and garden of George Eastman, must be seen. The Dryden Theater, adjoining the historical and modern displays of photographic art at the Eastman House, shows early motion pictures every Sunday afternoon.

About 90 per cent of the country's motion-picture film is manufactured in the world's largest camera and film plants located in Rochester. Photographic, precision, optical and scientific instruments supply Rochester with over 50 per cent of its business, requiring a large percentage of highly skilled industrial workers. The clothing and shoe industries account for another 20 per cent with radios, check protectors, and other industries contributing substantially to the total. The Rochester area has nearly 1100 manufacturing establishments employing approximately 380,000 people. In the short time available, the committees in charge of planning the meeting have scheduled inspection trips that will give delegates a good cross section of Rochester's diversity of industry.

Inspection Trips

The inspection trips scheduled so far include the Eastman Kodak Company, affording the visitor an opportunity to find out why the camera "goes wrong"; the Gleason Works, which company has pioneered in the development of straight bevel gears, spiral bevel gears, ZEROL bevel gears, hypoid gears, and CURVIC couplings; The Bausch & Lomb Optical Company—they helped glamorize the American aces during World War II with goggles that soon assumed the proportions never before known in history—makers of scientific optical instruments and ophthalmic products of the highest professional standards. The company is celebrating its 100th anniversary this year. Almost every time the doctor sticks a thermometer into your mouth, you can thank Taylor Instrument Companies; they also make hydrometers, meteorological instruments, barometers, and blood-pressure instruments. Here also the visitor will see the instruments better known only to industry. The Pfaulder Company is the originator and world's largest producer of glassed-steel proc-

ess equipment. Located about eight miles north of the city on the south shore of Lake Ontario is Russell Station of the Rochester Gas and Electric Corporation. This $25 million, three-unit station is modern, attractive, and one of the country's most efficient installations of power generation.

Get-Acquainted Party

An innovation for a Fall Meeting will be a "Get-Acquainted" Party scheduled at the Sheraton Hotel on Sunday evening preceding the regularly scheduled sessions. This party is being sponsored by the Bausch & Lomb Optical Company, internationally known manufacturers of optical goods, who are celebrating their 100th anniversary this year. We are assured of an auspicious beginning for the Fall Meeting by this reception.

Women's Program

The program planned for the women is a busy one full of many interesting, educational, and sight-seeing things to do. To start off there is a visit to Kodak Park—aside from the photographic equipment, and so on over 3000 chemicals and vitamins are produced here. At the end of the tour luncheon will be served in the Kodak Recreation Building. The afternoon will be spent touring the Lake Ontario area on to Durand-Eastman Park, the residential and commercial section, and up to Cobbs Hill Park for a bird's-eye view of the city. From there to Highland Park, famous for its lilacs, a tour of the Eastman School of Music will be followed by tea at the Rochester Club, the evening at the George Eastman House.

Tuesday is devoted to a trip to Letchworth State Park, which extends along both sides of the spectacular Genesee River Gorge. The Gorge is often called the "Grand Canyon of the East." Here the visitors will see the new Federal flood-control dam. Luncheon will be served at the Glen Iris Inn, home of the late William P. Letchworth, who gave the initial 1000 acres for the park. In the evening the banquet will be held.

Wednesday a style show will be staged and brunch served at Sibley, Lindsay and Curr Company, a department store now observing its 85th anniversary. In the afternoon anyone who desires, may see other points of interest in the city such as the Susan B. Anthony house, the Memorial Art Gallery, and the Bausch Museum.

GENERAL COMMITTEE FOR 1953 ASME FALL MEETING TO BE HELD IN ROCHESTER, N. Y. OCT. 5–7

(At a committee meeting held in the director's meeting room, Bausch & Lomb Optical Company, Rochester, N. Y., are shown, *left to right*, Roy A. LeBlanc, George E. Lawrence, Albert E. Schell, Arthur W. Schuster, James A. McConnell, Mrs. Phillip M. Kimmell, E. Roy Birkicht, *vice-chairman*, Carl L. Bausch, *chairman*, George T. Dibble, Arthur S. Hamilton, Jr., Stanley C. Stacy, David B. Vernooy, and Herbert Ashcroft, Jr.)

Committee

The following committee is in charge of arrangements: Carl L. Bausch, *chairman;* E. Roy Birkicht, *vice-chairman;* Robert G. Chapman and Meriwether L. Baxter represent the Executive Committee of the Rochester Section. The chairmen of the various subcommittees are as follows: Roy A. LeBlanc, *Information and Registration;* George E. Lawrence, *Plant Trips;* Albert E. Schell, *Finance;* Arthur W. Schuster, *Hotel;* James A. McConnell, *Publicity;* Mrs. Phillip M. Kimmell, *Women's Program;* Ernest W. Neben, *Entertainment;* Arthur S. Hamilton, Jr., *Technical Events;* Stanley C. Stacy, *Reception;* David B. Vernooy, *Printing;* and Herbert Ashcroft, Jr., *Plant Trips*.

ASME Membership as of May 31, 1953

Honorary Members	50
Fellows	388
Members	13,578
Associates	340
Juniors (33 and over)	3,425
Juniors (30–32)	2,011
Juniors (to the age of 29)	17,258
Total	37,050

Lehigh Conference Studies Air Pollution and Quality Control of Anthracite

SMOKE continues to be the first and most important source of air pollution in most cities, Louis C. McCabe, chief of the Fuels and Explosives Division of the U. S. Bureau of Mines, told more than 200 delegates attending the opening session of the eleventh anthracite conference held May 7-8, 1953 at Lehigh University.

"The interest in the complex chemical and metallurgical air-pollution problems calls attention to the necessity for smoke abatement wherever it exists," he said. "In almost every instance, whatever the cause of air pollution, smoke abatement is the first effort of enforcement officials. Success in this phase of the problem is rather dramatic. If the cost of attaining it is not too great a burden on the consumer, it is attained without the necessity of extensive research."

L. C. Dubs, president, Canton (Ohio) Stoker Corporation, urged that the anthracite industry enter into a co-operative arrangement with stoker and equipment manufacturers "to speed up the development of burning, handling, and control equipment, so that coal may regain its rightful place in the national fuel-burning picture and promote the development of one of our greatest national resources."

New development in pyramid grates were described by Henry K. Eliers, Pyramid Grate Company, New York, N. Y., at the opening meeting. He cited that new equipment "retains all of the advantages of cleanliness and low cost with more efficient utilization of fuel, and a lengthening out of the firing interval.

This lone-firing, hand-fired system offers the anthracite industry an opportunity to maintain many of its present commercial users at a low initial cost. It will provide a saving in labor over many other hand-fired methods for using anthracite, it is claimed. Equipment, which with proper maintenance will last as long as the boilers themselves, can be purchased for less than the cost of any other equipment, providing comparable savings."

In order to hold its present markets and expand by creating new ones, the anthracite industry must furnish a product of the highest quality, according to David B. Baird, Pottsville, Pa.

"In view of the fact that the anthracite industry is facing a buyer's market, the subject of quality control and inspection is of utmost importance to the public," he said. "Coal, like most other commodities, is sold on a basis of comparison."

Open curing of bright-leaf tobacco with anthracite, Paul F. White, Anthracite Institute, Philadelphia, Pa., said "offers the advantages of extreme fuel economy, shorter curing periods, and upgrading of the leaf." He discussed field experiments with co-operator-farmers during the past year.

"The number of anthracite systems is slowly expanding," he continued. "This is contrary to the belief once entertained that anthracite must close shop. The farmers are enthusiastic about anthracite because of its inherent cleanliness."

David J. Crawford, mining research engineer, Lehigh Navigation Coal Company, Lansford, Pa., reported on a mining-research program for the industry. He said, "costs for labor and material have been increasing, whereas the productivity per employee has been relatively constant. As a result, the price of a ton of anthracite has been progressively increasing. Unless this trend is arrested, there is danger that the costs will reach a point where anthracite will not be on a competitive basis with other fuels."

Mr. Crawford recommended that a research program be instituted to investigate the possible savings by development of new mining methods. "Through mechanization, improvements can be made in current mining practices to increase safety, reduce the losses of minerals incident to mining, and lower mining costs."

Kenneth E. Sanger, New York, N. Y., reported on engineering studies to develop ways and means of increasing the efficiency of the combustion of fuels. "In order to realize and maintain economies," he said, "there is need for independent engineering supervision bureaus which will act as consulting engineers for municipal plants."

J. R. Bright Gives Clayton Lecture

IN delivering the James Clayton Lecture to The Institution of Mechanical Engineers last Friday, April 17, 1953, Mr. James R. Bright, Mem. ASME, expressed the thoughts of many engineers when he said that "the cream has been skimmed off a good many production techniques." The one technique which was still not explored to anything like its full potentialities, even in the United States, was, in his opinion, materials handling, and this was the subject of his lecture, on "How American Industry Is Attacking the Problem of Materials Handling." Seldom has a lecture been of such universal significance to industry generally. Mr. Bright, who is chief editor of *Modern Materials Handling*, covered the subject in great detail and his lecture will be an invaluable guide to all managers and engineers who wish to apply the basic principles of the subject to their plants. Mr. Bright dealt with the neglected field of "short-range transportation"—a phrase which embraces the techniques of movement other than normal transportation by sea, rail, road, and so on, and moving things within arm's reach (which is covered by motion study). He established the case for more intensive study of short-range transportation by a few well-chosen statistics. Thus, for example, the materials for a certain aircraft component were in the works, from receipt to dispatch, for 240 hours, but only slightly more than 10 hours of this time were devoted to actual processing. Various studies and numerous estimates had shown that materials-handling costs varied from 30 to 90 per cent of total production costs. In another factor, it was found that for every ton of finished products dispatched, 50 tons of materials entered the plant. Mechanized handling techniques were essential to the realization of the full potential of such high-speed machinery. They could be used to reduce unit production costs, to increase the capacity per unit area of plant, to increase the safety of personnel, to reduce damage to materials, and to improve the salability of the product. Britain's annual wage bill for manufacturing industries was, he said, about 2500*l.* million. Of this, about 30 per cent was spent on materials handling, and this 30 per cent could itself be cut by, say, 30 per cent, thereby reducing costs by 200*l.* million or 300*l.* million.

Operations Research Society First Annual Meeting in Cleveland

OVER 300 people were on hand for the first annual meeting of the Operations Research Society of America in Cleveland, Ohio, May 15-16. The program was under the chairmanship of Robert F. Rinehart of Case Institute of Technology, and the sessions were held at the Hollenden Hotel and at the Case Institute.

The meetings on the first day, led by David B. Hertz, Mem. ASME, of Columbia University, were concerned with providing a definition of "operations research," and a description of the type of activity engaged in by operations researchers. George Kimball of Columbia University, one of the pioneers in the field, and the coauthor of a book on operations research, claimed the emergence of a body of basic theory unique to OR, naming as members of this group (1) search theory, i.e., the search for information, (2) information theory, i.e., the storage and collection of information, and (3) decision theory, i.e., the use of information to reach a decision.

Robert A. Bailey of Lockheed Aircraft, explained the activities of his group in aiding military planners by use of systems analyses. With today's highly advanced state of weapon technology, there are a wide variety of weapons systems which are in fierce competition for the military's dollars. By analyzing the proposed systems in light of their future operational requirements, Mr. Bailey's group provides the weapon planners with a basis for deciding on the most effective system. His analysis must take into account such nebulous factors as future goals of both ourselves and any potential enemy. Then, by application of scientific techniques, quantitative answers to a predetermined measure of effectiveness are determined.

Operations-research people must have access to all pertinent information, both internal and external, according to Leroy A. Brothers of the U. S. Air Force. They must be allowed to draw conclusions from their analyses as they appear, rather than be pressured into producing conclusions that might suit the political purposes of any single group or individual. It is largely for this requirement of freedom from pressure that he recommends that operations-research groups be placed outside the regular line of command, and that they act as advisers to the executive that uses their results for his decisions.

Mr. Brothers characterized the ideal operations-research study as one in which the following steps take place: selection of important parameters, gathering of data, analysis of the data, formulation of the cause-and-effect theory, testing of the theory on additional data, and use of the theory as a means of prediction. The result of this study then appears as a recommendation for action to be taken on the basis of the demonstrated results.

Technical sessions were concerned with specific tools used in solving operations-research problems. Sampling theory and linear programming were two such devices which came in for their share of attention. The former is a technique by which a statistical sample is taken of all the pertinent information in an accounting or clerical problem, and conclusions are drawn about the complete picture on the basis of the sample. In linear programming, a mathematical model of a physical situation is formulated so that the interrelations of all the pertinent parameters are expressed by sets of linear equations, appropriate constraints are placed on the parameters, and the operational conditions of the physical situation are determined by simultaneous solution of the equations.

The application of the theory of games to operations research was discussed in a session led by Thomas E. Caywood of Armour Research Foundation. This theory describes situations where there are opposing sides, each with various strategies at his disposal, trying to maximize his pay-off.

C. Hollister of Case Institute and S. B. Littauer of Columbia University reported on the courses in operations research being offered by their institutions. Both have undergraduate and graduate programs under the direction of the industrial-engineering department.

ECPD Announces Pamphlet on Careers in Engineering

ENGINEERS' Council for Professional Development has prepared a pamphlet entitled "Engineering—A Creative Profession," to aid in encouraging young people to choose engineering as a career.

The pamphlet discusses the meaning of engineering and the different phases it may take. It also tells what the prospective engineer should study in high school and how he is trained in the engineering colleges. The various branches of engineering are described in detail and the opportunities and fields of work are pointed out.

Fully illustrated, the pamphlet details how important choosing the right college is in the career of a professional engineer. Information is also included on scholarships, women in engineering, technical institutes, the organization of the engineering profession, and so on.

The pamphlet is available from ECPD, 29 West 39th Street, New York 18, N. Y., price 25 cents per copy; 20 cents a copy in quantities of 50 or more.

The President's Page

Sound Depreciation Policy As Insurance Against Depression

OUR distinguished contemporary, *Chemical Engineering Progress*, carried in its February, 1953, issue pointed comment by C. G. Kirkbride, vice-president of The American Institute of Chemical Engineers, in which it is urged that the Congress of the United States remove all limitations on amortization and depreciation rates under the Federal tax laws as a peacetime measure to stimulate the demand for capital goods and thereby ensure a high level of prosperity for our Nation.

It is heartening to see the professional-engineering societies taking up the cudgels for liberalization of the Treasury Department's misguided regulations with respect to depreciation and amortization of capital expenditures. This is a cause which is fraught with special interest to the engineer since the present policy acts as a powerful brake on the modernization of industrial plants and thereby seriously impedes their efficiency. This in turn restricts production and curtails earnings, which increases costs and reduces the tax base. Furthermore, it long has been recognized that business recessions are inevitable concomitants of low activity in the capital-goods industries.

Much of the confusion which exists among engineers, tax analysts, and accountants regarding depreciation policy would be swept away if the deduction allowed for income-tax purposes as depreciation on a capital asset were redefined, for what it really is, as a "Capital Recovery Allowance." It will be obvious that if a manufacturer is required to wait far beyond the efficient life of a piece of equipment before he can recover his investment in it, he will tend, if not indeed be forced to delay correspondingly the replacement of the asset when obsolescence sets in. As a minimum, the period of turnover of capital invested in the tools of production should be related realistically to the period during which such tools can be operated at a high rate of efficiency relative to other equipment of like character and purpose. Since the manufacturer himself is the best judge of what this period is, in view of his intimate knowledge of the nature of his product and his problems, the determination of the "useful life" for tax purposes should be left to the taxpayer. Certainly the burden of proof of improperly rapid depreciation of capital assets should rest on the Treasury Department instead of on the taxpayer, as regulations (though not the law itself) have required ever since 1934. Happily, there is some evidence of progress toward this objective in the new directive issued by the Commissioner of Internal Revenue early in May, instructing Revenue employees to propose adjustments in depreciation deductions only where there is a clear and convincing basis for a change. This appears to be a significant milestone in the 20-year struggle for a sensible depreciation policy.

Your President who has labored for nearly two decades in the forefront of this movement hails our sister Society, The American Institute of Chemical Engineers, for taking a forthright position in the matter and commends similar effort to the consideration of the members of The American Society of Mechanical Engineers everywhere.

FREDERICK S. BLACKALL, JR., *President*
The American Society of Mechanical Engineers

PRESIDENT BLACKALL PRESENTS OGP PIONEER AWARDS (*left to right*) TO S. B. DAUGHERTY, F. G. HOBART, AND C. G. A. ROSEN

ASME Oil and Gas Power Division Holds Twenty-Fifth Annual Conference

Big Turnout at Milwaukee Meeting

THE Oil and Gas Power Division is the oldest of the professional divisions of The American Society of Mechanical Engineers, dating its first organized activities from 1908. Twenty-five years ago, in 1928, a two-day meeting for ASME members and others interested in gas and oil engines was held at State College, Pa., with the assistance of the mechanical-engineering department of The Pennsylvania State College. About 30 attended that first conference and a number of technical papers were presented.

Since then, continuous and steady development has taken place. Annual conferences held in various parts of the country have attracted ever-increasing numbers of interested engineers and the presentation of many significant papers on subjects of concern to the builders and users of internal-combustion engines has been significant.

This year at the Schroeder Hotel, Milwaukee, Wis., the twenty-fifth Oil and Gas Power Annual Conference and Exhibit took place from May 25 to 28 under the sponsorship of the Oil and Gas Power Division and the Milwaukee Section of the Society. The registered attendance of 413 closely approached the record set in 1952 at Buffalo, N. Y.

P. B. JACKSON DELIVERS TALK TO OGP CONFERENCE

The Milwaukee Section, as host, participated actively in all conference events and gave a popular and greatly enjoyed buffet dinner and entertainment for visitors and local members at the Milwaukee Athletic Club. A. W. Colwell of A. O. Smith Corporation, Milwaukee, is Section chairman. Robert Cramer, Jr., Nordberg Manufacturing Company, Milwaukee, served as chairman in charge of conference arrangements, with Robert D. Teece, Harnischfeger Corporation, Milwaukee, as co-chairman.

An interesting and pleasant program was arranged for the women by the Milwaukee Section of the Woman's Auxiliary to the ASME under the chairmanship of Mrs. W. A. Alexandroff. This included trips to nearby points of interest and participation in several social hours.

OGP Exhibit

The value of each conference has been greatly enhanced by the presence and co-operation of exhibitors interested in the Oil and Gas Power Division activities who displayed new equipment and materials. This activity has expanded with the years until the twenty-fifth annual conference included the presentation of 37 individual exhibitors, a number of whom have participated in many of the past annual meetings. The successful progress of OGP is very largely due to the loyal support of the exhibitors.

The conference was opened with a welcome luncheon at which A. W. Colwell of the ASME Milwaukee Section presided. P. B. Jackson, Development Division, Aluminum Company of America, Cleveland, Ohio, an active member of the Oil and Gas Power Division, who holds the record of attending every conference, presented a brief review of the Oil and Gas Power Division's history, pointing out the location of many of the past conferences and outlining the changes undergone in the operations of the division. A cordial welcome to the conference and guests was extended by Robert W. Hansen of the Milwaukee Port Authority.

The high point of the conference undoubtedly came at the conference dinner held on Tuesday night and attended by about 300, presided over by Karl W. Stinson, Ohio State University, Columbus, Ohio, the chairman of the Oil and Gas Power Division Executive Committee. A. W. McKinney, National Supply Company, president of the Diesel Engine Manufacturers Association, served as toastmaster.

Pioneers Honored

The Oil and Gas Power Division, believing that this twenty-fifth conference was a most appropriate time, arranged for the honoring of three, long-time members of ASME, now retired, who had been active in the early days of the internal-combustion-engine industry and who have each participated significantly in the development of large gas and oil engines. The awards were made in recognition of pioneer contributions to the field of internal-combustion engineering. Following the reading of each citation by L. N. Rowley, Jr., of McGraw-Hill Publishing Company, New York, N. Y., suitably inscribed certificates were presented by Frederick S. Blackall, jr., president of ASME, to: Samuel Bovard Daugherty, Mem. ASME, Orchard Park, N. Y., associated with Worthington Corporation, Buffalo, N. Y., and predecessor companies; Franklin G. Hobart, Fellow ASME, Beloit, Wis., consulting engineer, Fairbanks, Morse & Company, Beloit, Wis.; and Carl G. A. Rosen, Fellow ASME, Peoria, Ill., consulting engineer, Caterpillar Tractor Company, Peoria, Ill.

The speaker of the evening, President Frederick S. Blackall, jr., gave an inspired talk on the subject "Europe's New Challenge to American Industry." He had returned, only a short time before, from an extended trip throughout most of Western Europe during which he had an unusual opportunity to visit many of the most important European builders of all types of machinery. His personal observations and the information gathered, shared with an attentive audience, led to the inescapable conclusion that American builders of machinery must take advantage of every technological advance in order to hold a share of world-wide markets.

Many Timely Papers Presented

The location for this year's conference was especially appropriate for an Oil and Gas Power

meeting as Milwaukee is a center of important manufacturers of large internal-combustion engines.

The four OGP technical sessions were well attended and covered such subjects as refrigeration units for utilizing waste-heat energy of engines, valve-gear fundamentals for the large engine designer, photographic study of events in a 14-in. two-cycle gas engine, investigation of combustion-flame temperatures, design of arc-web crankshafts, and supercharging without a blower.

Two timely papers were devoted to the use of heavy or residual fuel oil in diesel engines.

An extremely interesting discussion was held on diesel plant design under the chairmanship of E. C. Shum, Baldwin-Lima-Hamilton Corporation. The panel members included engineering executives of consulting engineers, important diesel-engine builders, and power plants.

General Technical Committee

A very well-attended and popular event at each conference is the evening session devoted to the meeting of the General Technical Committee. This is a group, selected by invitation from all branches of the internal-combustion engine and allied industries, which discusses informally subjects of general engineering interest. The subject this year was "Ignition Systems for High-Compression Gas Engines." With M. J. Reed, Socony-Vacuum Oil Company, Inc., New York, N. Y., as acting chairman, a panel of representatives of engine builders, manufacturers of gas-engine ignition equipment, and engine operating organizations discussed various sides of the subject. Since this matter is of wide interest, the audience provided active discussion from the floor and it was agreed that the session was most successful.

OGP Special Lecture

A conference feature which has been presented annually for several years is the annual Oil and Gas Power Special Lecture. Each year a different subject is presented by a leading authority who has been invited for that purpose.

For the 25th Annual Conference, T. E. Eagan, research metallurgist, Cooper-Bessemer Corporation, Grove City, Pa., gave a thorough and valuable discussion on "The Cast Ferrous Metals." Mr. Eagan's lecture will be included in the published proceedings of the Oil and Gas Power Division and represents a valuable contribution to the literature.

One of the most interesting features of each conference is the plant visits. Fairbanks, Morse & Company, Beloit, Wis., and Nordberg Manufacturing Company, Milwaukee, hospitably opened their engine-building plants for inspection tours. Conference visitors were able to obtain comprehensive and interesting views of modern methods and machinery used in building diesel, dual-fuel, and gas engines.

At the conclusion of the conference, Professor Stinson, the outgoing chairman of the OGP Division, received a vote of thanks and appreciation for the excellent job he had done. The incoming chairman, taking office for the coming year, is George J. Dashefsky, U. S. Navy Yard, Brooklyn, N. Y.

ASME Petroleum Division Meeting Rice Hotel, Houston, Texas, Sept. 27–30, 1953

THE Houston Executive Committee in charge of arranging the 1953 meeting of the Petroleum Division of The American Society of Mechanical Engineers, to be held at the Rice Hotel, Houston, Texas, Sept. 27–30, 1953, includes the following: chairman, L. S. Wrightsman, Humble Pipe Line Company; vice-chairman, G. E. Nevill, Cameron Iron Works; secretary, H. H. Meredith, Humble Oil and Refining Company; treasurer, M. I. Kearns, Brown-Bellows-Smith, Inc.; and committee members, J. P. Mooney, Humble Oil and Refining Company and R. B. Kinzbach, Kinzbach Tool Company.

Additional information regarding the meeting, plant trips, and social events will be announced in forthcoming issues of MECHANICAL ENGINEERING.

Tentative Program

Transportation

Gas-Turbine Application in Gas-Transmission Lines, by *S. Sawyer*, El Paso Natural Gas Co.

Microwave Control of Pumping Stations, by *R. C. Cheek*, Westinghouse Corp.

Radioactive Isotopes in Pipe-Line Interface Marking, by *J. Kohl*, Tracerlab, Inc.

Experiences With Tri-Fuel Engines in Pipe-Line Service, by *Meade and Jennings*, Phillips Co.

Materials

Cast Iron in the Refinery, by *W. J. Buxton*, Standard Oil Co.

Monel Protection for Off-Shore Structures, by *T. P. May*, International Nickel Co.

Why Prestressed Concrete in the Refinery, by *A. C. Bidwell*, Esso Standard Oil Co.

Production

Formation of Martensite on Rotary Drilling Lines, by *C. M. Zerr*

Vibration Problems on Barge-Mounted Power Rigs, by *Herndon and Reese*

Applications of Friction and Hydraulic Drives to Drilling Rigs, by *M. L. Rizzone*

Holding Power of Casing Hanger Slips, by *E. F. Cooke, Jr.*

Low-Temperature Separation and Gas Dehydration As Practiced in Louisiana, by *J. E. Orrell*

A Sonic Oil-Well Pump, by *A. G. Bodine, Jr.*

ASME Calendar of Coming Events

Sept. 21–25
ASME Industrial Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Sherman Hotel, Chicago, Ill.
(Final date for submitting papers was May 1, 1953)

Sept. 28–30
ASME Petroleum Mechanical-Engineering Conference, Rice Hotel, Houston, Texas
(Final date for submitting papers was May 1, 1953)

Oct. 5–7
ASME Fall Meeting, Hotel Sheraton, Rochester, N. Y.
(Final date for submitting papers was June 1, 1953)

Oct. 29–30
ASME Fuels Division and AIME Coal Division Joint Conference, Conrad Hilton Hotel, Chicago, Ill.
(Final date for submitting papers was June 1, 1953)

Nov. 29–Dec. 4
ASME Annual Meeting, Statler Hotel, New York, N. Y.
(Final date for submitting papers was July 1, 1953)

People

BOYD B. BRAINARD, Mem. ASME, professor, mechanical-engineering department, Kansas State College, has accepted a temporary appointment at the University of Rangoon, Burma.

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The U. S. Air Force's rarely conferred Exceptional Service Award was presented posthumously to the General Electric Company's pioneer jet engineer, DONALD F. WARNER, Mem. ASME (see the May, 1952, issue of MECHANICAL ENGINEERING, page 442), who directed development of the first turbojet in America. In recognition of Mr. Warner's outstanding contributions to jet aviation, the Award was given to his wife, Mrs. Mildred Warner, at the Jet Pioneers Association's annual banquet held April 30, 1953, at Lynn, Mass., by Brig. Gen. D. J. Keirn, Air Force officer originally in charge of the pioneer jet project.

* * *

EMIL H. PRAEGER, designer of Normandy invasion concrete floating breakwater, received the first "Metropolitan Engineer of the Year" Award in recognition for his concept and design of Pier 57, Hudson River. The award was presented at the annual meeting of the Metropolitan Section of the American Society of Civil Engineers held May 20, at the Engineering Societies Building, 33 West 39th Street, New York 18, N. Y.

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BENJAMIN F. FAIRLESS, chairman of the board of directors and chief executive officer of the United States Steel Corporation, received the Vermilye Medal from The Franklin Institute for his outstanding contributions to the field of industrial management. Formal presentation of the award was made May 20 when Mr. Fairless delivered the Edward G. Budd Lecture.

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HOWARD L. BENDER, assistant director, research and development department, Bakelite Company, a division of Union Carbide and Carbon Corporation, received the twelfth annual John Wesley Hyatt Award for the Advancement of Plastics, May 10, at an award ceremony aboard the S. S. *Queen of Bermuda* en route to Bermuda.

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R. R. DANIELSON, manager of ceramic serv-

ice, Metal and Thermit Corporation, New York, N. Y., became the fifty-fifth president of the American Ceramic Society when he took office at the banquet on April 28, during the annual meeting held at the Hotel Statler, New York, N. Y. At the meeting WALTER A. WELDON, of Baltimore, Md., received the Charles Fergus Binns Medal for distinguished achievement in ceramic art. FLOYD A. HUMMEL, professor, school of mineral industries, The Pennsylvania State College, received the Ross Coffin Purdy Award for the most valuable contribution to ceramic technical literature during 1951.

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ROBERT RINEHARDT of the Case Institute of Technology was elected president of the Operations Research Society of America. The other newly elected officers include JACINTO STEINHARDT, director, U. S. Navy's Operations Evaluation Group, vice-president; JOHN B. LATHROP of Arthur D. Little Inc., secretary; and ALFRED N. WATSON of Curtis Publishing Company, treasurer.

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ARTHUR R. DIAMOND, Mem. ASME, vice-president of Tools Incorporated, Philadelphia, Pa., has been reappointed chairman of the National Education Committee of the American Society of Tool Engineers. This committee recently announced the names of the winners of ten annual $700 awards to students at ECPD approved engineering schools for their senior year or for a year of graduate study. CORNELIUS R. BITELER, Purdue University; NATHAN OSER, University of Pennsylvania; RICHARD W. WAMBACH, Cornell University; and KENNETH D. WILSON, University of Iowa, all student members of ASME, were among those who received awards.

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CARL E. NAGEL, formerly assistant to the president of the McGraw-Hill Book Company, was recently appointed vice-president and managing director of the Council for International Progress in Management (USA), Inc.

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GROVER C. MUTCHLER, *right*, vice-president in charge of research and development of the Mack Printing Company since 1950, was recently honored in observance of his fiftieth anniversary in the service of the company and its antecedents. HARVEY MACK, president of the company, congratulated Mr. Mutchler and praised his loyalty and assistance through the years. A resolution was drawn up and presented to Mr. Mutchler which recorded briefly his progress in the company, his technical assistance, his cordial relations with his fellow workers, and the good wishes of his friends. He also received a complete golf set.

ASME Elects Four Fellows

THE American Society of Mechanical Engineers has honored four of its members by electing them to the grade of Fellow of the Society.

To be qualified as a nominee to the grade of Fellow one must be an engineer who has acknowledged engineering attainment, 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and has been a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or members of the Society to the Council, to be approved by Council.

The men whose outstanding contributions to their profession and to the Society were so honored are:

Clarence Barton Campbell

CLARENCE B. CAMPBELL, consulting engineer, Steam Division, Westinghouse Electric Corporation, South Philadelphia plant in Lester, Pa., has been with his present company for the past 34 years. He joined Westinghouse as a technical apprentice following graduation from the University of Michigan and rose through the ranks to his present position. He has held supervisory positions in the engineering department of the Steam Division since 1930. For eight years Mr. Campbell was Design Division engineer at the company's South Philadelphia Works. In 1938 he became manager of Land-Turbine Engineering. From 1944 to 1952 he was manager of the Steam Division's engineering department. Mr. Campbell was awarded the Westinghouse Order of Merit in 1942. He has been active in ASME affairs, serving on many national and local committees including the Publications Committee of which he was chairman in 1952. He served as a member of the Executive Committee, Philadelphia Section; Section Chairman, 1950-1951. He was a delegate to the World Power Conference in London in 1950 at which time he presented a paper on "Trends and Development in Steam Turbine Practice for Central Station Service." Mr. Campbell is the author of many publications. He holds several patents on steam-turbine control and governors and mechanical improvements in steam turbines.

John Raymond Michel

JOHN R. MICHEL, general system engineer, Commonwealth Edison Company, Chicago, Ill., has made outstanding contributions in the field of electric-utility operation, engineering, research, and development. In his work with Commonwealth Edison Company and with the Power Generation Committee of the Association of Edison Illuminating Companies, he has contributed much toward the development of fuel-burning and steam-generating equipment from the early natural draft stoker and small low-pressure boiler installations to the one-million-lb-per-hr pulverized coal-fired and cyclone-fired steam generators of today. Mr. Michel has also co-operated with leading manufacturers and consulting engineers in the development of present-day 180,000-kw capability, and above, steam-turbine generators and in the design of complete modern centralized-control power plants. Mr. Michel joined Commonwealth Edison in 1923 as a student engineer. From 1925 to 1939 he held various engineering operating positions including responsible charge of a complete generating station, its operation, maintenance, performance, and personnel. For the next four years he was in charge of all power-plant testing in the company. In 1946 he became assistant to the vice-president in charge of operating and engineering. Mr. Michel has been active in Society affairs; in the ASME Chicago Section he was chairman in 1942-1943. At present he is chairman of the Fuels Division; member of the Air-Pollution Controls Committee and of the Research Committee on Low-Temperature Flue Gas Corrosion and Deposits. During World War II, at the request of the War Production Board, he successfully organized Chicago's leading engineering and scientific society groups to aid jointly in the war effort. This resulted in two annual meetings of the combined group. Mr. Michel made the Chicago Section a sponsor of the Midwest Power Conference. He is the author of several papers.

Frank William Miller

FRANK W. MILLER, vice-president in charge of manufacturing, Yarnell-Waring Company, Philadelphia, Pa., has made outstanding achievements in many phases of mechanical engineering and management. He joined Yarnell-Waring when it was a young company devoted largely to the manufacture of a single product—boiler blowoff valves—and advanced himself to positions of increasing engineering and management responsibility through notable contributions to the progressive development and growth of the company. His work over the earlier years involved contributions and supervision of practically all phases of mechanical-engineering activity, including product development, application engineering, production, materials procurement, and inspection. This included such work as pioneering in designing for higher steam pressures and participating in engineering, installation, and research testing with a new 2500-psi research boiler which at the time was considered to be one of the highest-pressure water-line boilers in existence (1931). After 1945 as works manager and later in his present position, he made further contributions to the planning of plant extensions, improvement of manufacturing methods, streamlining of production flow through the plant, and standardization of rates and procedures. Mr. Miller has also done much to improve plant working conditions as well as working for the maintenance of good employee-management relations. He has been active in ASME affairs especially on the Constitution and By-Laws Committee. He was chairman of the Philadelphia Section of ASME, 1944-1945. He has been active in

the Engineers' Club of Philadelphia for several years, being president in 1951-1952. Mr. Miller holds four patents and is the author of several papers.

Mortimer Freeman Sayre

MORTIMER F. SAYRE, professor of applied mechanics, Union College, Schenectady, N. Y., and now chairman of its recently established department of mechanical engineering, has made outstanding contributions in the field of education and as an engineering consultant. Professor Sayre has taught at Union College since 1914. From 1942 to 1945 he was director of engineering, science, and management war training at the college. Starting in 1945, he directed the Extension Division of the college for four years. For many years he has been in charge of instruction in mechanics of materials and in thermodynamics at Union College. As an engineering consultant, Professor Sayre has contributed greatly in developing new materials, design, and design theory for General Electric Company, the American Locomotive Company, the Clifford Manufacturing Company, and John Chatillon & Sons. He is in charge of laboratory work at the college for General Electric. He has added greatly to the knowledge of metallurgy including development of "Condal" aluminum alloy and isoelastic alloy. He has helped to develop basic data in spring design and materials, and aided in developing improved types of creep-testing machines. Professor Sayre has been active in technical society affairs. For ASME he served on the Research Committee on Mechanical Springs and as chairman of the ASME Schenectady Section, 1928-1929. Professor Sayre has had more than 30 articles published and is the author of the Section on Springs in "Kent's Mechanical Engineers' Handbook," 1938 edition, and the Compression Testing Section, "American Society for Metals Handbook," 1948 edition.

ASME Boiler Code Committee Meets With ISO in Paris

IN 1949 the International Standards Organization (ISO) asked the Boiler Code Committee of The American Society of Mechanical Engineers to accept the Secretariat of ISO/TC11 "Unification of Boiler Codes" for the American Standards Association. The object of this technical committee is to develop an international boiler code so that modern boilers built in one country will be accepted for installation in other countries. Some countries now have their own boiler codes, others have none, and some that are in existence are inadequate to cover modern steam generators. The lack of uniformity of boiler codes creates many problems which hinder the development of international trade in boilers.

The Boiler Code Committee accepted the Secretariat and appointed a special committee to work on this project. With the co-operation of a British delegation in 1950, a Draft Proposal was prepared and sent to all nations interested in this standardization project for comments.

The first meetings of ISO/TC11 were held in Paris on May 11 to May 20, 1953. The American delegation was led by F. X. Gilg, The Babcock & Wilcox Company, and included John L. Menson, Combustion Engineering Inc.; Henry H. Hemenway, Foster Wheeler Corp.; E. O. Bergman, C. F. Braun & Company; C. W. Wheatley, A. O. Smith Corp.; D. L. Royer, Ocean, Accident & Guarantee Corp.; H. B. Oatley, chairman, ASME Boiler Code Committee; and C. O. Myers, National Board of Boiler & Pressure Vessel Inspectors. Mr. Oatley was elected chairman to conduct the meetings. The official languages were English and French. Interpreters and translators were provided by ISO.

For this first meeting there were 76 delegates from Austria, Australia, Belgium, France, Germany, Holland, Italy, Spain, Switzerland, United Kingdom, and the United States. Having in mind that ISO has some 70 technical committees in existence, we were deeply impressed when informed that this was the largest ISO meeting ever held, a tribute to the interest in boiler construction all over the world. This was the first timet hat boilermakers and engineers from so many nations had an opportunity to sit around a table to discuss their mutual problems.

The great interest shown in boiler construction indicates that there is a real need for an international boiler code. The co-operative spirit among the various delegations in arriving at compromises, not yet permitted by their respective boiler laws, indicates that the prestige of an ISO Code or Recommendation would be very strong and that they really want boiler rules and regulations which would have international standing.

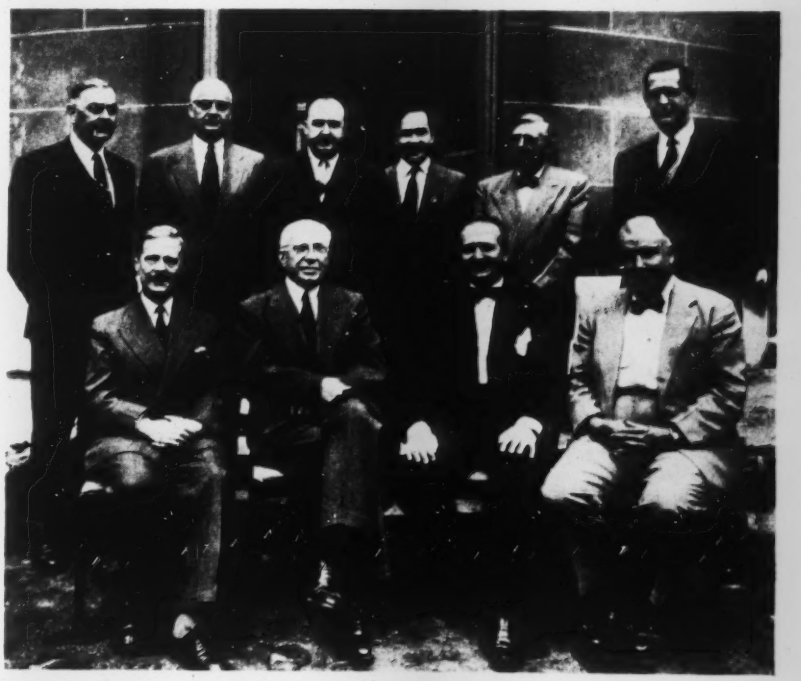
Agreements were reached on 12 Draft Resolutions, including a design formula for cylindrical shells, rules for riveted construction, and inspection and stamping. After some discussions in working groups, three Subcommittees were recommended to continue discussions on:

1 Materials
2 Allowable stresses and design formulas
3 Welding

These Subcommittees will carry on by correspondence and local meetings the work that was started at the Paris meeting. To make it easier to get this work accomplished without transatlantic travel, Germany was invited to take the Secretariat of the Committee on Materials; France, the Committee on Allowable Stresses and Design Formulas; and Holland the Committee on Welding.

Since the ASME Boiler Code Committee is the Secretariat for ISO/TC11, they will charge these subcommittees to resolve their differences by correspondence or local meetings. It is hoped that another meeting of the full committee can be held in about two years to finalize the discussions, so that an ISO Recommendation can be circulated for approval.

On the subject of allowable stresses, it was quite obvious that the European boilermakers, with the exception of the French and British, use higher stresses than we do, resulting in thinner drums and tubes. They base their allowable stresses on a factor of safety of 1.5



THE AMERICAN DELEGATION TO THE BOILER CODE MEETING IN PARIS

on the yield strength at temperature, whereas for carbon steels, we base ours on a factor of safety of four on the ultimate strength at room temperature. The subcommittees will get together, compare boiler materials from various countries, and arrive at a suitable stress table. It is hoped that some agreement will be reached which will enable all countries to build boilers for the export trade to the same ISO recommendation.

While the agreements reached by ISO/TC11 may have some long-range effect on boiler laws in the various countries, boilers built for installation in this country and Canada will always have to comply with the ASME Boiler and Pressure Vessel Code.

Nation's Strength Endangered by Military Manpower Demands

A CREEPING growth of control by the military over an increasing segment of the manpower and brain power of this country is a dangerous fact that needs immediate recognition by the American people. "Over 25 per cent of all engineers and scientists engaged in research and development programs in the country—the very people on whom we depend for our continued technological and economical superiority—could be placed in uniform tomorrow with a snap of the Pentagon's official finger." This startling information was revealed by T. H. Chilton, chairman of the Engineering Manpower Commission of Engineers Joint Council at a special conference at The Engineers' Club of New York, on May 28.

"This situation is the logical result of the operation of our military service laws as they are now written," Dr. Chilton declared. He pointed out that when the Korean Action began, great industrial dislocation was caused by the indiscriminate withdrawal for military service of key personnel who had voluntarily been in the military reserves. "Since then," he added, "Public Law 51 has created a compulsory reserve into which military personnel go upon completing their active service—this includes all Selective Service inductees as well as ROTC graduates and others. This reserve pool, which is expanding every day, will shortly exceed 10 million and includes an increasing proportion of those people who are vital to our defense production economy."

"The recalling of reservists to active duty in time of emergency or war rests solely in the hands of the Department of Defense. This situation," Dr. Chilton cautioned, "can create chaos in the industrial support of mobilization."

"In short," he said, "we have not only ignored the military reserve realities taught by the Korean incident, but we have set the stage for an even worse situation. In this connection, it is interesting to note," he emphasized, "that in a report recently submitted to President Eisenhower, 'A Policy for Scientific and Professional Manpower' by the Columbia University National Manpower Council (a body created in 1950 by Dwight D. Eisenhower), it was recommended, and I quote: 'The President initiate a review of the existing legislation and administrative procedures governing the recall of reservists to active duty in order to develop a system that will provide for civilian participation in determining the distribution of scientific and professional personnel required to meet military and civilian needs.' "

The Manpower official then stated that a bill has been recently introduced into the Congress to amend the Armed Forces Reserve Act of 1952 to correct this situation. The bill (H.R. 3893 and S. 1551) provides for the orderly and selective recall to active duty in the military services of members of the military reserves so as to afford the most effective utilization of manpower resources of the United States. It was introduced into the House of Representatives by Congressman Leroy Johnson of California, chairman of the Subcommittee on Reserve Affairs, and into the Senate by Ralph E. Flanders, Hon. Mem. ASME, Senator from Vermont, a member of the Armed Services Committee.

Dr. Chilton pointed out that this bill would establish a National Manpower Board in the office of the President to formulate criteria and procedures governing the call to active duty of our growing reserve. The board would be composed of both military and civilian persons who are familiar with the needs of the armed forces, defense production, and the national health, safety, and interest and at the same time familiar with the functions of specialized personnel including the professions. The Board would act as a final appeal board in cases which do not fit the criteria, thus providing judicious consideration to our manpower needs for total national defense.

"During hearings held prior to the passage of the Armed Forces Reserve Act of 1952," Dr. Chilton continued, "the only source of opposition to the general principles in this bill was the Department of Defense, as far as could be determined." He pointed out that the need for such an administrative manpower structure was recommended by the Engineering Manpower Commission of Engineers Joint Council and other nationally known scientific, professional manufacturing, labor, and agricultural organizations.

The Senate Subcommittee conducting hearings and Senator Russell B. Long (La.) acting as chairman recognized the importance of this in its reports of the hearings. Dr. Chilton then quoted from the statement of Senator Long's Subcommittee, "The Committee is of the opinion that a reasonable portion of the reserve must remain at the disposal of the military for prompt call when authorized by Congress. However, as the size of the reserve gradually increases each year, until it ultimately includes all of the manpower pool, it is highly questionable, on the basis of the facts now at hand, whether the selection for mobilization of these great numbers can and should be made exclusively by the military.

". . . this problem is . . . one of deep concern to the committee . . ."

Other organizations with representatives at the conference who agree in principle with the Chilton statement are as follows: Alden H. Emery, the American Chemical Society; M. H. Trytten, American Institute of Physics; Walter E. Lawson, Armed Forces Chemical Association; B. R. Makela, Chamber of Commerce of the United States; D. B. Keyes, National Association of Manufacturers; Howard A. Meyerhoff, Scientific Manpower Commission; C. A. Parris, National Electrical Manufacturers Association; J. A. Gosnell, Manufacturing Chemists Association.

In concluding, Dr. Chilton emphasized that this is not a problem of resolving disputes between military and civilian points of view or between the civilian and military elements of our economy. "It is actually the development of a sound solution to the problem of equitably distributing our manpower between the consumer and the producer to meet the needs of national security. Someone must make the weapons. Otherwise our men in uniform will be reduced to the use of clubs."

Opportunities in Aviation Discussed at International Aircraft Show

CAREERS in engineering was the subject of a forum held on Thursday, June 11, 1953, at the Statler Hotel, New York, N. Y., as a part of the second International Aviation Trade Show under the auspices of the Aircraft Trade Shows, Inc.

Over 100 students and parents from the New York and New Jersey areas heard a discussion of careers in engineering by W. T. Cavanaugh, assistant executive secretary, Engineering Manpower Commission of Engineers Joint Council, and Frank Pac, employment manager of the Sperry Gyroscope Company. This portion of the program was presented by EMC in co-operation with the Aviation Division of The American Society of Mechanical Engineers.

Mr. Cavanaugh, in his opening remarks, emphasized the fact that in the age of science we have neglected the teaching of science and in so doing have created the need to acquaint our people with the scientific and engineering aspects of their way of life and their effects on our high standard of living. To the parents and students present, he sketched the long-range need for technical personnel in an industrial structure in an ever-increasing complexity and size and the consequent opportunities for intelligent, inquisitive, and industrious young men and women for careers in technology. He cautioned, however, that young people and their parents should realize the over-all requirements for a successful engineering career before making career decisions.

Mr. Pac emphasized the important needs of industry for young engineers and sketched the programs which exist at the Sperry Corporation to help young engineers in their career development. Included among these was Sperry's Tuition Refund Plan to encourage and promote graduate study and therefore continue career improvement among their own engineers.

The talks were followed by a question-and-answer period in which specific problems of career guidance were discussed. Emphasis here was placed on the necessary high-school preparation for successful entry in engineering schools and the successful completion of formal engineering training.

The original patent for a "flying machine" issued to Orville and Wilbur Wright was publicly exhibited for the first time as part of the Fiftieth Anniversary of Flight display at the show. The patent is owned by the Wright Aeronautical Division of the Curtiss-Wright Corporation, a direct descendant of the Dayton-Wright Company formed by the Wright brothers after their historic flight at Kitty Hawk on Dec. 17, 1903.

Junior Forum

Conducted by Joseph Schmerler, Jun. ASME

Why Formal Industry-Training Programs?

By Warren R. Thompson[1]

MUCH has been written in recent years on the subject of formal industry-training programs. These articles describe at great length how a company can turn a college graduate into a useful engineer after a period of supervised training.

The more elaborate of these programs place the men in one department after another for a given period of training. After the orientation period the trainees are supposed to know what the various departments do, what their problems are, and be able to decide which departments would suit them best. Sometimes the descriptions of these formal training programs sound and act like the conducted sightseeing tours that are available in any large city.

At the other end of the scale is the rough-and-tumble school of no formal industry-training program. This school of thought maintains that when a man is graduated from college he is an engineer. It is true that he does not have broad technical experience, but he does have the technical training. Between the two extremes there are many types of training programs, each one designed, it is hoped, to fit a definite and specific need.

One reason for a formal industry-training program is obviously to acquaint the college graduate with the business practices of the company. This portion of the training program is designed to show the trainee the function and organization of the various branches and departments and their relation to each other. This is helpful background for the new employee, but it has little direct bearing on his usefulness as an engineer. Certainly an engineer just out of school can make his calculations and studies without knowing how the shipping or accounting departments operate. By the time an engineer has advanced to the position where he needs knowledge of how the other departments work he will have acquired it by association.

A second reason advanced for a formal industry-training program is to teach the details of the company's products. This is advantageous for those who go into sales work. It gives him, in a relatively short time, a picture of his future jobs. However, for the graduate who has the inclination or desire for engineering work alone such a survey only provides useful background information. When he starts his work in engineering it will be on one product or more likely on small components of one product. As he gains in experience and knowledge he will get to know in greater detail the advantages and limitations of many of the company's products.

Perhaps the most important reasons advanced for a formal industry-training program are those which pertain to the furthering of individual initiative and to helping the young engineer find his place in the company. Initiative is a trait that is practically impossible to develop by any formal training methods. If a young engineer likes his work and can see a reason for it he almost instinctively will take steps to help do the job in a better and more expeditious manner. In a formal training program it may be many months, or even years, before he is able to apply himself to a specific assignment with the knowledge that he will not shortly be transferred to another department. It is only then that the company begins to derive proper benefit from his services.

In those companies where there is no formal industry-training program, such as small manufacturers and service organizations, competent engineers are still developed. In many cases they are developed more rapidly. When the college graduate is hired he is placed on a specific job and is expected to produce to the limits of his ability. He will, in a short time, become familiar with the operations of other departments because his specific assignment will require him to co-ordinate his work with others.

In this first assignment he will begin to show initiative and organizational ability. Since there will be a deadline to meet because construction on fabrication must start, he will have to gather his data, organize it, analyze it, and use it to arrive at a satisfactory answer.

This approach to the training of the young engineer is a rigorous one for all concerned, especially so for the young engineer. In some respects it may be analogous to the philosophy of "sink or swim." It places upon the individual the responsibility for his professional development. It places upon the company the responsibility of having available senior engineers who can help the younger man collect his thoughts. It is almost certain that a college education will not be detailed enough to cover the specific job assignments a young engineer will receive. He must therefore do extra study to gain the technical knowledge required to perform his job properly. The young engineer may find it to his advantage to start postgraduate studies in his chosen field.

Placing young engineers in specific jobs and allowing them to work by their own resources has another distinct advantage. No two engineers get identical training. By placing them on different jobs they develop as the job requirements progress. After a period of time each will have covered a wide range and each will know his particular field well. The company will thereby benefit by having an engineering force of wider detailed background in a shorter time than would be possible if all the young engineers were subjected to the same formal training. If, at any point along the line of development, it is found that the young engineer does not have the capability to handle his job, the company and individual benefit by knowing it at an early stage. The individual can be transferred without wasted effort to another assignment where he will fit more properly.

This type of employment for the college graduate places certain responsibilities upon the employer as well as the graduate. If the young engineer is to develop rapidly without a formal training program, he must have superiors of such caliber that they will be willing and able to help him through the rough spots. Both the superior and the young engineer have the technical training, but it is the superior who has the experience and he must, to the best of his ability, pass it on to the young engineer.

The employer must be willing to increase the young engineer's remuneration as he develops. Professional pride and loyalty to a company are important factors for contentment in a responsible position, but the size of the salary check, in the last analysis, has an important bearing on whether or not to change jobs. The employer must also promote the young engineer to a more responsible position just as soon as he is ready to take the step. With such a promotion the company must also increase the authority by which the young engineer can carry out his job. These basic facts of company policy are of little use, however, unless they are communicated to all concerned the young engineer and his superiors.

This discussion recognizes the value of formal industry-training programs, especially for those entering sales functions of industry. For others who plan to enter specific engineering branches of industry, less stress should be placed on a formal training program covering other phases of a company's operations, and more emphasis on individual development in engineering.

[1] Engineer, United Engineers & Constructors Inc., Philadelphia, Pa. Jun. ASME.

Actions of the ASME Executive Committee

At a Meeting at Headquarters, May 19, 1953

A MEETING of the executive committee of the Council was held in the rooms of the Society on May 19, 1953. F. S. Blackall, jr., chairman, presided. In addition to Mr. Blackall there were present H. E. Martin, A. C. Pasini, and W. F. Thompson of the Committee; E. J. Kates, assistant treasurer; E. G. Bailey, past-president; H. R. Kessler, vice-president; C. E. Davies, secretary; and Ernest Hartford, executive assistant secretary. A joint meeting of the Executive Committee of the Council and the Finance Committee was held for the purpose of discussing the 1953-1954 budget and transacting other business. The following actions taken at the Council meeting were of general interest:

Mexico Section

In 1951 the Council authorized Section status for the Mexico Group for two years "to be extended at the discretion of the Council." C. H. Shumaker, acting vice-president, Region VIII, reported that a letter had been received from J. M. Zilboorg, chairman of the Mexico Section, requesting an extension of its authorization to function, for an additional three-year period starting Oct. 1, 1953. The Regional Administrative Committee of Region VIII recommended this extension. The Council voted to authorize the Mexico Section to continue to function until Sept. 30, 1956, under the original terms and conditions.

New Subsection

Establishment of the Northern New Jersey Subsection of the Metropolitan Section was approved. This Subsection will consist of the counties of Passaic, Bergen, Essex, Hudson, Morris, and Sussex, in the northern part of New Jersey.

Roy V. Wright Lecture

The Secretary reported that the Roy V. Wright Lecture at the Columbus Spring Meeting was delivered by the Hon. Frank J. Lausche, Governor of Ohio.

Calvin W. Rice Lecture

The Council voted to extend an invitation to J. Foster Petree, editor of *Engineering*, London, England, to deliver the Calvin W. Rice Lecture at the Rochester Fall Meeting on Oct. 5, 1953.

Certificates of Award

Certificates of Award were voted for Gardner M. Ketchum, chairman, Schenectady Section, 1952-1953, and James E. Waldrep, chairman, Greenville Section, 1952-1953, to be awarded at the completion of their terms of office.

Certificate of Award was granted to S. M. Watson, Jr., secretary-treasurer, Greenville Section, 1951-1953.

Upon the recommendation of the Power Test Codes Committee, a certificate of award was granted to George A. Horne for "outstanding leadership in the development of the Society's Power Test Codes."

Exchange of Greetings

The president reported an exchange of cablegram greetings between the presidents of the American Society of Civil Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, and the presidents of The Institution of Civil Engineers, The Institution of Mechanical Engineers and The Institution of Electrical Engineers of Great Britain, on the occasion of a special luncheon arranged for past-president R. J. S. Pigott, in London, on April 8.

Appointments

The following appointments on committees and joint activities were approved:

C. H. Weaver to Nuclear Energy Application Committee

H. Poritsky to Research Committee on Lubrication

W. G. Snyder to Subcommittee on Nonferrous Materials, Boiler Code

E. E. Edgecomb, Conference Committee, Boiler Code

W. B. Wilkins, T. D. Perry, and N. C. Bye to ASA Project—Performance Standards for Small Sawmills, B66

F. S. Blackall, jr. to John Fritz Medal Board of Award (4-year term)

R. B. Lea to Daniel Guggenheim Medal Board of Award (3-year term)

J. F. Roberts to Washington Award Commission (2-year term)

The following presidential appointments were confirmed:

L. C. Morrow to Gantt Medal Board of Award

P. B. Eaton, representative to celebration of enrollment of six-millionth student, International Correspondence Schools, May 20.

Harry W. Edwards, of ASME Staff, Dies

HARRY W. Edwards was one of the most highly regarded persons ever to work for The American Society of Mechanical Engineers. He instilled a fine team spirit as personnel manager, using understanding, wisdom, and a natural sense of humor to smooth out problems arising in employee relations. His untimely death on May 26, 1953, occurred in his 47th year.

Many of his assignments from the Secretary's Office required tact. Others called for careful planning and gathering of hard-to-get facts. Invariably he would come in with a workable solution. He had a large part to play in the "new look" of the ASME office—in the refurbishing of the Council room and other smaller meeting rooms. He planned and supervised the moving and consolidation of small departments to provide better working conditions and more efficient operation.

Mr. Edwards was born in Muncy, Pa., April 28, 1906. He was graduated from the Richmond Hill (N. Y.) High School and later studied banking and finance at the New York University. He furthered his studies in corporation finance, investment principles and practices, office administration, and allied financial studies at the New York Stock Exchange Institute. To round out his business education he took courses in personnel management, industrial relations, labor, and management at Manhattan College. During World War II he attended the U. S. Army Service Force School for Personnel Officers.

HARRY W. EDWARDS

A thumbnail sketch of his business activities includes structural-steel work under the supervision of his father, who was superintendent, John A. Roebling's Sons Company of Trenton, N. J.; several years in Wall Street with some of the leading brokerage firms; World War II service, first with the British Purchasing Commission and later with the New York Ordnance District, Army Service Forces, as chief, Civilian Personnel Branch, under Brig. Gen. S. E. Reimel, Mem. ASME, for which service he received the Commendation for Meritorious Civilian Service from the War Department, Army Service Forces; and at the time of his death he had been with ASME over five years.

He had been a member of the New York Personnel Management Association and ex-chairman of the Federal Personnel Council of Metropolitan New York.

He is survived by his wife, Muriel; and two children, Grace and Tommy.

Coming Meetings

Briquetting

THE third biennial briquetting conference will be held Aug. 31-Sept. 1, 1953, at Banff Springs Hotel in the Canadian Rockies.

The briquetting industry of the United States and Canada together with the Natural Resources Research Institute of the University of Wyoming are developing an outstanding program of papers and plant visits to some of Western Canada's new and modern drying and briquetting plants.

Discussions on coal drying, briquetting of taconite and nonmetallic minerals, testing procedures for coal briquettes, and operational problems are planned.

Interested persons and companies should contact Neal Rice, coal research chemist at the Natural Resources Research Institute, University of Wyoming, Laramie, Wyo., for further information.

Plasticity

THE fourth symposium on plasticity will be held at Brown University, Providence, R. I., on Sept. 1–3, 1953. The three principal topics of this symposium will be stress-strain relations (perfectly plastic, work-hardening, viscoelastic, and viscoplastic materials); distribution of stress and strain in bodies exhibiting inelastic properties (static and dynamic problems, infinitesimal, and finite deformations); and structural analysis and design in the inelastic range (limit analysis, static and dynamic loading, shakedown, and inelastic buckling).

For further information write to Prof. H. J. Weiss at the Graduate Division of Applied Mathematics, Brown University, Providence 12, R. I.

Machine-Tool Exhibition

THE third European machine-tool exhibition, organized by the European Committee for Co-Operation of Machine Tool Industries, will be held in Brussels, Belgium, between Sept. 4 and 13, 1953. Twenty-one American manufacturers will exhibit their products at the show. The products of over 700 manufacturers from 11 countries will be on view.

In addition to machine tools and portable tools for the working of metals, the exhibit will include measuring, controlling, and testing instruments; welding equipment; die-casting machines; heat-treating equipment; and electrical, pneumatic, and other auxiliary equipment. A number of publishers of technical books and magazines will have booths at the show.

Further technical information, as well as a folder giving general information for visitors, may be obtained by writing to Leon G. Rucquoi, technical consultant to the Belgian Metalworking Industry, 30 Rockefeller Plaza, New York 20, N. Y.

Nuclear Engineering

ON Sept. 9, 1953, a three-day conference on nuclear engineering will convene at the University of California, Berkeley. The conference is presented by the University's departments of engineering at Berkeley and Los Angeles, in co-operation with Northern California sections of AIChE, AIEE, and ASA; Southern California sections of ASME, AIChE, and ASM; and the Committee on Atomic Energy Education of ASEE.

The major purpose of the conference is to provide a high-level technical program of contributed papers by and for personnel working in nuclear engineering and closely related fields. Papers will deal with selected unclassified, or declassified results of investigations concerned with the utilization of nuclear reactions. The program will feature technical and engineering economic studies of nuclear power plants, other reactors, isotope production and separation, and isotope applications. Several invited speakers will also present papers, mainly providing reviews and integrated discussions of important topics and problems in the field.

Education

Fulbright Awards

ANNOUNCEMENT was recently made for the 1954-1955 competition for Fulbright awards for university lecturing and postdoctoral research in Europe and the Near East, Japan, and Pakistan. Application forms and additional information are obtainable from the Conference Board of Associated Research Councils Committee on International Exchange of Persons, 2101 Constitution Avenue, Washington 25, D. C. Applications for university lecturing and advanced research must be postmarked no later than Oct. 15, 1953.

Graduate students desiring to enroll for courses abroad or to pursue a directed program of studies of the predoctoral level should apply to their local Fulbright Adviser or directly to the Institute of International Education, 1 East 67th Street, New York, N. Y.

Management

A SPECIAL graduate degree program designed to train engineers for positions in management has been announced by the College of the City of New York school of business and civic administration.

The program will be open only to graduates of accredited schools or colleges of engineering.

Upon completion of the requirements, the student will earn a master of business administration degree in industrial management. The program may be completed, on a full-time basis, in one summer session and two regular semesters, or, on a part-time basis, in one summer session and four regular semesters.

The program was planned to meet industry's demand for engineers with management-level business training in addition to their technical background.

Among the courses offered toward the degree are personnel administration, job evaluation and wage incentives, industrial supervision, time and motion techniques, cost accounting, labor-management relations, cost reduction and control, and techniques of management survey.

Requests for applications and further information should be addressed to the Office of Graduate Studies, City College School of Business, 17 Lexington Avenue, New York 10, N. Y.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th Street	84 East Randolph Street	100 Farnsworth Ave.	57 Post Street

Men Available[1]

Engineer, 38, BSME, MS, PE in Ill.; married; five years production, development, and design; nine years teaching engineering. Seeks responsible position in production management or production engineering. Middlewest preferred. Me-970-625-C.

Sales Manager, 40, MS(ME); offers seasoned, mature approach in technical selling to industrials and in developing loyal, hard-hitting sales force. Solid background. Family man. Midwest preferred. Me-971-626-C.

Sales Engineer, 34, married, BS(ME). Estimating, sales, and engineering experience in industrial construction and shipbuilding. Presently employed; have car. Prefers northern New Jersey. Me-972.

Sales and Project Engineer, 33, married, extensive background in the sale and promotion of process equipment and complete processes for food, chemical, and allied industries. Desires responsible sales position with a progressive Calif. process-equipment manufacturer. Available six weeks from date of mutual acceptance. Prefers Calif. Me-973-535-D-3.

Administrative Engineer, 36, BSME, PE. Plant and process design, construction, maintenance—experience both chemical and process industries. Plant-site selection, investigations, reports for top management. Desires permanent location, family. Me-974.

Electromechanical Engineer, BSME, MS, five years' experience in development and design of airborne equipment, instruments, and computers; seeks responsible position with small engineering firm on East or West Coast. Me-975.

Chief Power-Plant Engineer, 46, 20 years' experience in three positions as assistant chief engineer, chief engineer, and manager of hydro and steam-electric system. Seeks permanent position supervising modern steam-electric utility or industrial plant. Me-976.

Mechanical Engineer, 34, PE, 11 years devoted exclusively to design, manufacture, and operation of heavy machinery. Desires challenging position of responsibility requiring creativeness and ingenuity with heavy-machinery manufacturer. Me-977.

Industrial Engineer, 30, BS, married. Presently on active duty as a Lieut., USAF. Six months' design experience, 1½ years Air Force accounting. Desires all-round I.E., i.e., time study, job evaluation, etc. Will relocate. Available, Aug. 8th, 1953. Me-978.

[1] All men listed hold some form of ASME membership.

Hydraulic Engineer, MSME, 28, married, veteran. Experienced in power-plant engineering. Desires position as hydraulic-testing or development engineer in connection with dam and channel flows, performance characteristics of hydraulic turbines, and other related work in field of hydroelectric power. Will relocate. Me-979.

Mechanical or Instrument Engineer, 31, BSME, married. Experienced paper and synthetic-fiber industry. Interested in working with a technical director or other plant executive. Administrative and supervisory ability. Me-980.

Manufacturing Executive, 47, married, advanced degrees, many years administrator engineering development, industrial engineering, manufacturing. Also experience sales, accounting, personnel, finance. Well-rounded background enables training others and moving to greater responsibilities. Automotive, aircraft, machinery, materials. Excellent health. Available about 30 days' notice. Prefers West Coast. Me-981-456-D-3.

Project Engineer, 32, married, Reg. ME, BS. Two years plant layout, one year plant engineer, four years plant facilities design and installation. Present project near completion. Prefers Northwest. Me-982-536-D-1.

Management Engineer, 18 years' successful experience in electrical, metal-products, and photographic industries. Top-notch administrator with proved ability to effectively handle diverse personnel. Master's degree, 39, presently employed, desires challenging management opportunity. Me-983.

Chief Engineer or Plant Engineer, 41, married, BSME, PE in Calif. Considerable experience in chemical-process-plant engineering department administration and supervision of design, construction, and maintenance. Capable organizer. Available in Sept. Prefers Calif. Me-984-364-D-7.

Positions Available

Production Engineer, mechanical or electrical graduate, at least five years' experience covering manufacture of capacitors for electronic equipment. $8000-$12,000, plus bonus. Central N. Y. State. Y-8620.

Sales Engineer for sale of air and liquid-filtration equipment to original-equipment manufacturers in the East Coast area. Mechanical engineer, under 40, some previous sales background and experience with diesel engines, pumps, compressors, etc., preferred. Duties include some office work, service work, etc., and some traveling. Recent graduate considered. $5000-$7500. Headquarters, N. J. Y-8626.

Executive Engineer, 35-45, college degree, majoring in mechanical or industrial engineering, for manufacturers of gears, speed reducers, power transmissions, special machinery, and other products made to very close tolerances. Should have administrative experience and heavy background of product engineering with responsibility for manufacture or application. Duties will involve managerial responsibilities over engineering activity, in the field of manufacturing engineering, application engineering, and new product development. $18,000-$20,000. N. Y. metropolitan area. Y-8629.

Engineering Staff Assistant to General Sales Manager. Must have minimum of five years' design experience on aircraft structures and must know ways and means of using fasteners and their application to such structures. Must have sales personality and management background. Considerable travel. $10,000-$12,000. Northern N. J. Y-8633.

Mechanical Engineer, considerable experience in tools, jigs, and fixtures, and the writing of operation sheets for precision-machine shop doing mostly job-shop precision work. $8000-$9000. Northern N. J. Y-8641.

Engineering Personnel. (*a*) Chief development engineer, 35-45, mechanical or electrical, broad technical knowledge and experienced in design for mass production of low-cost electromechanical-precision assemblies. Will assume full responsibility for the development and execution of broad policies, objectives, and programs of product development and development engineering, etc. $12,000-$15,000. (*b*) Chief production engineer, 35-50, broad shop experience in tooling and engineering mass production of small electromechanical products. Will report to works manager; must assume full responsibility for all tool design and construction of tools either in own toolroom or at bona fide subcontractors. Such tools include expendable tools, jigs, and fixtures, gages, and capital equipment. Assume full and final responsibility on all production-engineering problems, etc. $10,000-$13,000 Western N. Y. State. Y-8655.

Design and Development Chief Engineer for 50-man engineering department, with substantial experience in electrical and mechanical engineering and design, with stress analysis, also in administration. Design is for both standard and special equipment to conform to customer conditions. The product is material-handling equipment powered with battery. $10,000-$12,000. Mass. Y-8659.

Product Designer, mechanical-engineering training and at least five years' design and development experience covering small mechanisms, to design and develop parts and components for use in electronic equipment—gear trains, chassis, variable condensers, and other small aluminum and brass-metal products. $8000-$10,000. Mass. Y-8663(*a*).

Mechanical or Industrial Engineer, 28-35, at least five years' industrial-engineering experience in precision-products field, to set up and operate cost-accounting system for watchcase manufacturer. $8000. Northern N. J. Y-8668.

Senior Methods Analyst, 30-40, mechanical or industrial degree, five to seven years' experience in office-methods improvement, formulate standardization program, make cost-reduction survey, and installation. Some travel. $8500-$10,000. New York, N. Y. Y-8670.

Chief Engineer, 15 to 20 years' experience, to supervise an engineering department of about 20 people on operation, maintenance, and planning for minor additions. Should have some background in mechanical, electrical, and civil engineering, preferably with experience in design or operation of natural-gas engines and pipe lines. $12,000-$15,000. Mich. Y-8679(*a*).

Cost-Reduction Engineer, 30-45, degree in industrial engineering preferred, seven to 10 years' experience in industrial-engineering functions with several years spent in supervision of these activities with manufacturing of small electromechanical devices or control mechanisms, including time and motion study, methods, tooling and processing and utilization of equipment. $9000-$12,000. Ill. Y-8682(*b*).

Chief Development Engineer, 35-45, mechanical or electrical, broad technical background, and a competent administrator. Experienced in design and development of low-cost electromechanical assemblies for mass production. Must be extremely cost-conscious. Will take complete responsibility for design and development of new products in the fields of subfractional electric motors, motor-driven fans and ventilators, automotive electrical switchgear. $13,000-$15,000. Upstate N. Y. Y-8698.

Chief Engineer, graduate, 10 to 15 years' experience in medium and heavy industry. Company manufactures heavy conveying machinery. Will supervise 50 engineers and draftsmen. $10,000-$15,000. Mass. Y-8710.

Industrial Engineers, preferably with diversified industrial experience. Should have extensive knowledge of materials handling, production control, methods, plant layout, and time study. Two-year contract. $10,500-$11,000, plus rent and heating costs. South and Central Americas. F-8711.

Production Engineer, mechanical graduate, at least 10 years' experience covering punch-press operations, screw machines, dies, tooling for manufacturer of electromechanical devices in precision-products field. $15,000-$17,000. Brooklyn, N. Y. Y-8718.

Manager of Engineering, 35-45, engineering graduate, successful experience in industrial engineering covering plant layout, materials handling, packaging, cost analysis, budgets, and supervisory administrative experience to take charge of industrial-engineering staff for large food organization. $12,000-$15,000. New York, N. Y. Y-8719.

Industrial Engineer, 35-45. Must have industrial degree, and preferably MS. Should have had five or more years' experience in plant layout, time and motion study, rate study, wage-incentive plans, work-simplification methods. Should have background in MAPI and working knowledge of MTM. Should be able to develop methods of material-handling analysis, material flow, plant layout, and rate study. Prefer someone who has worked with G.E., Westinghouse, or companies that have actual industrial-engineering programs. $10,000-$12,000. New York, N. Y. Y-8723.

Assistant Professor or Instructor, young, to teach thermodynamics, aeronautics, heating and ventilating, and probably some mechanics in the mechanical-engineering department. Rank and salary dependent on qualifications. Liberal policy in granting leaves of absence on half salary to qualified instructors who wish to do graduate work. East. Y-8749.

Service Engineer, mechanical or electrical, for instrument company. Must be experienced in computer or instrument work in the field. Must be a matured experienced man to call on various air-force bases. Travel 95 per cent in U. S. $8000-$10,000 plus expense account. Headquarters, New York, N. Y. Company will pay placement fee. Y-8757.

Mechanical Engineer, 35-50, graduate, registered engineer preferred, five years' engineering experience, including experience as design engineer and/or plant engineer in chemical-process industries or metallurgical plants. Travel will be required within U. S. A. and Canada for service work and to effect design improvements based on observation of actual plant-operation conditions. Salary open. Calif. Y-8765.

Mechanical Engineer, design, methods, and production experience, to redesign for production military camera equipment. $7000-$8000. New York, N. Y. Y-8776.

Recent Graduate, mechanical, chemical, petroleum, geologists, physicists, and mining engineers, 22-30, single status. Will work on mud-logging units in the oil fields. Moving expenses paid. Training spots leading to petroleum engineering for an oil-well testing company. $4380. Texas. T-9939.

Project Engineer, mechanical or electrical, up to 45, at least two years' experience in design or development of controls with inventive and creative flair. Knowledge of electrical circuitry and make-and-break switches. Will design and develop new controls, some may be gas-control equipment, for a manufacturer of controls. $6000-$10,000. Company will pay placement fee. Ind. T-9946.

Designer, mechanical graduate, preferably with some pressure-vessel experience. Considerable individual responsibility in connection with numerous design engineering assignments on senior level concerning fabrication of wide variety and range of heavy-metal custom-built equipment for chemical industry. No board work. Company manufactures to customers' specifications items such as distillation columns, fractionating towers, condensers, heat exchangers. Salary open. Ohio. T-9967.

Sales Engineer, up to 50, at least two years' experience in sales of construction materials or materials-handling accessories. Knowledge of structural steel, electrical structures, or mechanical structures. Will sell or contact architects, engineers, contractors, or industrials for line of metal framing, for manufacturer of metal frames. $4800-$7200. Company will negotiate placement fee. Car required. Several locations open. R-9835.

Manufacturing Engineer, 25-40, at least two years' experience in practical work setting up production lines for aluminum extrusions, cutting, and assembling. Knowledge of machine tools and able to handle them himself. Will lay out production, jigs, tools, and fixtures for cutting and assembling aluminum-extruded products for a window manufacturer. Up to $8000, depending on experience. Employer will negotiate placement fee. Ill. R-9911.

Project Engineer, mechanical, up to 45, at least three years' experience in project work on fast-moving machinery such as packaging or paper-folding equipment. Knowledge of printing helpful. Will do project work in maintenance, design, and installation of very fast-moving, light automatic machinery for a manufacturer. Up to $8840. Company will negotiate placement fee. Ill. R-9925.

Welding Engineer, up to 35, MS in mechanical, electrical, or metallurgical engineering. At least two years' experience welding-research work. May consider recent graduate. Knowledge of ferrous metals and welding procedures. Will do research on welding projects for oil refinery; low-carbon and stainless-steel projects for an oil refinery. $5520-$8400. Ill. R-9942.

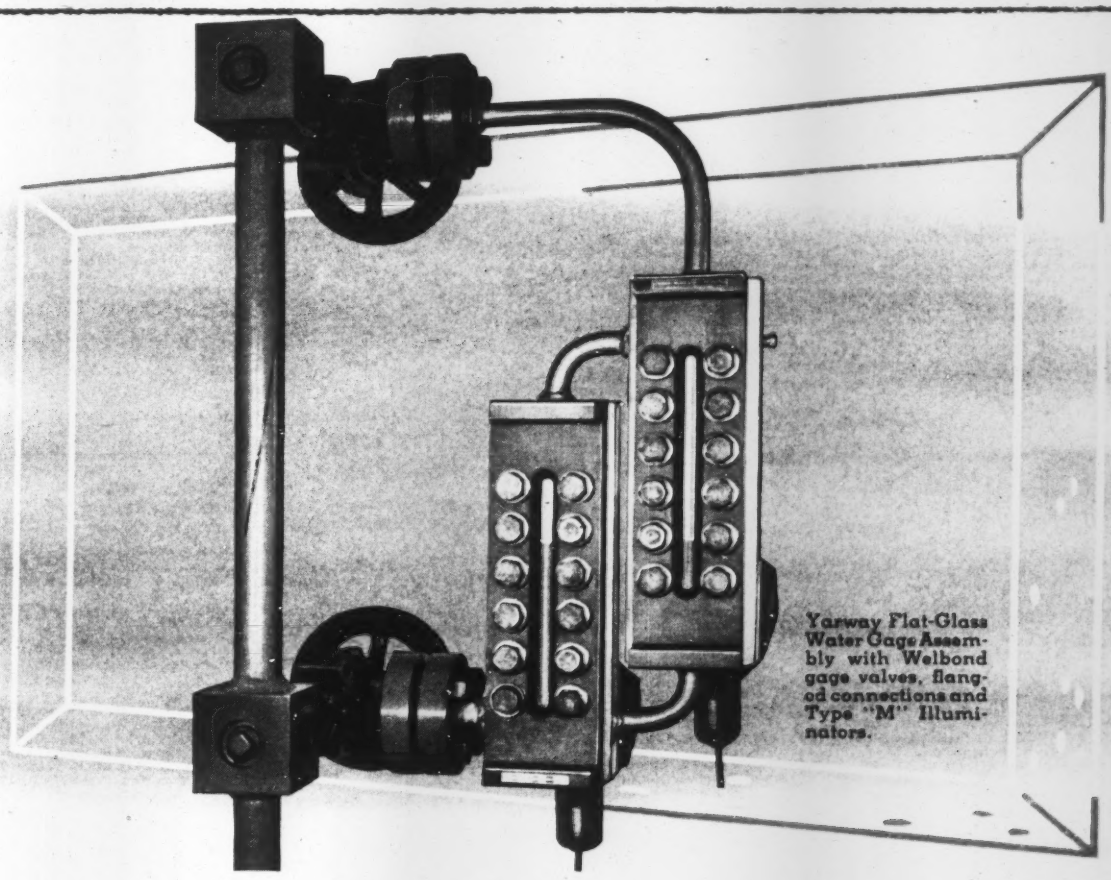
Assistant to Chief Engineer, over 35, mechanical, five years' experience in heavy-machine design and development. Knowledge of shop practices and foundry operations. Will assist chief engineer on design and development of packing-house equipment. Must have good personality, some customer-contact work involving application and plant layout. $10,000. Company will pay placement fee. Ill. R-9945.

Industrial Engineer, up to 45, IE or ME, five years' experience in industrial engineering with broad background. Knowledge of accounting procedures. Duties will include changing methods or procedures in any department within organization for a manufacturer of bottling machinery, industrial and medical gases, dry ice,

(*ASME News continued on page 608*)

What's New

IN BOILER WATER LEVEL INDICATION?



Yarway Flat-Glass Water Gage Assembly with Welbond gage valves, flanged connections and Type "M" Illuminators.

NEW *SEPARATED-DESIGN* WATER GAGES

This new Yarway water gage assembly has been developed to meet the demands for greater dependability, longer life, and more accurate readings in high pressure service.

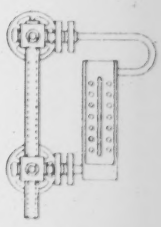
The gage glass inserts are of the Yarway pressure-sealed "floating assembly type". Yarway Welbond gage valves are used. Greater flexibility is gained by using two independent inserts, and by interconnecting expansion loops (see above).

The short connection to the drum assures greater accuracy of the gage reading, and the lower flanged connection eliminates a stuffing box. The upper flanged loop connection between the insert and gage valve allows expansion and contraction of the various components.

The tie bar-type water column linking the gage valves provides circulation to keep gage nearer drum temperature.

Yarway Type "M" Illuminators on the gage inserts cause the meniscus at water level to "shine like a star". This illuminator is especially effective in penetrating deposits on gage glass, dust particles in air and extraneous light.

For full information, write for Yarway Bulletin WG-1811.



Yarway Single Insert type gage for medium range of visibilities.

YARNALL-WARING COMPANY • 108 Mermaid Avenue, Philadelphia 18, Pa.

Branch Offices in Principal Cities

YARWAY **STEAM PLANT EQUIPMENT**

and allied products. $7500–$8000. Company will negotiate placement fee. Ill. R-9961.

Sales Engineer, 25–35, two years' experience in service or sales of special machinery. Will sell weighing and packaging machines to industrials. May be some service application and repair work. Will travel eight or nine midwestern states for a manufacturer. Car required. $4500–$5100. Headquarters, Ill. R-9971.

Plant Engineer, up to 40, at least three years' experience in plant layout and maintenance of metal-stamping field. Knowledge of plant protection. Will do plant maintenance, layout, and plant protection for metal-stamping and blanking plant for a manufacturer of stampings. $7800. Company will pay placement fee. Ill. R-9984.

Lubricant-Sales Engineer, up to 35, mechanical, industrial, or electrical, at least two years' experience in industrial sales and preferably lubricants or maintenance products of similar nature. Knowledge of industrial lubricants helpful. Will sell line of petroleum products to industrials for a major oil company. Up to $6000. Car furnished. Ill. C-1023.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after July 24, 1953, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member

NEW APPLICATIONS

For Member, Associate, or Junior

ABBOTT, GEORGE A., JR., Detroit, Mich.
ALVINE, RAYMOND G., Burlington, Iowa
ANDERSON, JOHN E., Dallas, Texas
ARAI, TSUTOMU, Tokyo, Japan
AVIS, RICHARD L., Seattle, Wash.
BACKER, WILLIAM R., Cincinnati, Ohio
BARBER, ROBERT W., Yardley, Pa.
BEAUCHAMP, JAMES M., JR., New Haven, Conn.
BECKER, EDWARD L., New York, N. Y.
BERCHER, DONALD J., Erie, Pa.
BEGGS, JOSEPH S., Pacific Palisades, Calif.
BEVERAGE, CHARLES B., Bremo Bluff, Va.
BOUCHE, RAYMOND R., Washington, D. C.
BROOKS, JAMES H., El Paso, Texas
BROUGH, CHARLES G., Front Royal, Va.
BUCHI, ALFRED J., Dr., Winterthur, Switzerland
BURZI, GUIDO, Bucaramanga, Colombia, S. A.
CAMPBELL, ALLAN N., Quebec, Can.
CAMPBELL, GORDON A., Minneapolis, Minn.
CAMPBELL, TOM C., Atlanta, Ga.
CASEY, JOHN R., Schenectady, N. Y.
CATRON, RUSSELL M., Carmel, Calif.
CLARK, LYLE G., Ann Arbor, Mich.
CLARKE, NORMAN P., Prairie Village, Kan.
CLINE, ROBERT C., Kingston, N. Y.
COLE, JORDON M., Chicago, Ill.
CONRAD, ARCHIE W., JR., Nashville, Tenn.
COSCIA, LEWIS, G., Baltimore, Md.
COWDEN, JAMES B., Pittsburg, Calif.
COYNE, IRA HIRAM, Davenport, Iowa
CRANS, ROLAND C., Detroit, Mass.
CRITTENDON, LEXIE RAY, Wilmington, Del.
DALAL, HOSHANG, F., Karachi, Pakistan
DAUB, LORIN R., Petersburg, Va.
DAYAL, PARANKUSAM, D., Bangalore, S. India
DEMPSEY, THOMAS F., San Carlos, Calif.
DI GIOVANNI, MARIO M., Pacific Palisades, Calif.
DITSWORTH, RICHARD, Ames, Iowa
ELIEZER, DONALD E., Poughkeepsie, N. Y.
EVANS, THOMAS H., Ft. Collins, Colo.
EWOUDS, THOMAS C., Gainesville, Fla.
FIELDS, JAMES B., New York, N. Y.
FIETSAM, RAYMOND K., Beacon, N. Y.
FLECKENSTEIN, RICO E., Easton, Pa.
FOURNIER, JEAN P., Colombes, Seine, France
FREW, WILLIAM R., Indianapolis, Ind.
FREY, CHARLES T., Highland, Ill.
FULLER, ARTHUR L., Sussex, England
GELOFF, DIMITRI, Syracuse, N. Y.
GILMARTIN, ROBERT P., Pittsburgh, Pa.
GODDARD, JORGE V., Tlalnepantla, Mex.
GRAY, HARRISON L., Watertown, Conn.
GREER, FREDERICK W., JR., Peterborough, N. H.
GREY, EDWARD C., Ann Arbor, Mich.
GUARINO, MICHAEL, Syracuse, N. Y.
GUPTA, ARUN KUMAR, Calcutta, India
HANCOCK, DONALD F., Summit, N. J.
HARTMAN, GEORGE J., Detroit, Mich.
HAWKINS, FRANK, Borger, Texas
HEDLEY, SIDNEY R., Los Angeles, Calif.
HEINEMAN, WILLIAM P., Shreveport, La.
HEISER, KENNETH RAY, Silvis, Ill.
HERRMANN, RICHARD G., Bronx, N. Y.
HICKEL, JAMES D., Cleveland, Ohio
HOOD, JOHN H., JR., Waterford, Pa.
HOWITT, THOMAS, JR., Corning, N. Y.
HRUBY, JOSEPH, Deerfield, Ill.
HUFFMAN, CHARLES H., Los Angeles, Calif.
JESSUP, JOHN W., JR., Poughkeepsie, N. Y.
JOHN, VICTOR P., Detroit, Mich.
JOHNSON, MELVIN M., JR., New Haven, Conn.
KENDALL, WALLACE C., Oreland, Pa.
KIEFER, HUGH M., Norco, La.
KINGREA, JAMES I., JR., Philadelphia, Pa.
KINYON, BRICE W., Oak Ridge, Tenn.
KJOLNER, THORGRIM E. K., Cleveland, Ohio
KNIFF THOMAS, J., JR., Cleveland, Ohio
KRAFT, RUSSELL H., Beacon, N. Y.
LAWRENCE, WILLIAM H., Milwaukee, Wis.
LEE, LAURENCE R., Scotia, N. Y.
LOBER, CHARLES G., Memphis, Tenn.
LONGENECKER, DONOVAN L., Aiken, S. C.
LORENSTEIN, LAWRENCE C. So. Charleston, W. Va.
LOTZ, RALPH W., Chicago, Ill.
LUDASY, AKOS, Birmingham, Ala.
MACCHIETTO, CHARLES F., Omaha, Neb.
MAGUIRE, WILLIAM T., Sea Cliff, N. Y.
MANN, RICHARD I., Saginaw, Mich.
MAY, STEPHEN C., Atlanta, Ga.
MCCONACHIE, ERIC C. B., Vancouver, B. C., Can.
MENGHINI, ALFRED G., Omaha, Neb.
MOYLE, MORTON P., Ann Arbor, Mich.
MUHR, ERNST, São Paulo, Brazil
NEWCOMER, GARFIELD H., Clifton Heights, Pa.
NULSEN, ERIC C., St. Joseph, Mich.
NUTTING, WILLARD H., Oakland, Calif.
O'KEEFE, WILLIAM, Rutherford, N. J.
ORLOSKI, STANLEY J., Bartlesville, Okla.
ORTINO, LEONARD J., Wappingers Falls, N. Y.
OSBORN, DAVID B., Ridley Park, Pa.
OXLEY, JAMES H., JR., Perrysburg, Ohio
PARROTTA, RALPH P., Lawrence, Mich.
PERREIRA, TIMOTHY B., Travancore, S. India
PETERSEN, SVEND A., Brooklyn, N. Y.
PHELPS, RICHARD T., JR., Pensacola, Fla.
PRAIRIE, EDWARD J., Hartford, Conn.
PROUT, WILLIAM L., Fishkill, N. Y.
PURDY, JAMES A., Abington, Pa.
PURPUS, THEODORE G., Minster, Ohio
RANKINE, HUGH G., Laurent, P. Q., Can.
RESWICK, JAMES B., Wellesley, Mass.
RILEY, FRANCIS L., Pepperrell Air Force Base, c/o PM, N.Y.
RODGERS, WILLIAM P., Borger, Texas
ROEDER, KENNETH G., New York, N. Y.
ROLLER, DONALD C., Poughkeepsie, N. Y.
RONEY, JAMES R., Borger, Texas
RUBINSTEIN, WILLIAM, Mattapan, Mass.
SANEMATSU, HENRY S., Los Angeles, Calif.
SCHWARTZ, MARTIN W., New York N. Y.
SCOTT, LESLIE B., Burlington, Iowa
SHOULBERG, ROBERT H., Cambridge, Mass.
SHURTLEFF, JAMES D., Euclid, Ohio
SLOMAN, ROBERT A., Wilmington, Del.
SMITH, LESLIE S., North Reading, Mass.
SMITH, THOMAS C., Poughkeepsie, N. Y.
STELZER, FRANK E., Fishkill, N. Y.
STEMSHORN, EDWIN P., St. Lambert, P. Q., Can.
STEWART, GORDON H. S., Chicago, Ill.
STITES, RICHARD, JR., San Francisco, Calif.
STUBBINS, ROBERT L., Altadena, Calif.
SWIATOSZ, EDMUND, Buffalo, N. Y.
TACCONK, RUSSELL W., North East, Pa.
TAWNEY, CHARLES H., JR., Baltimore, Md.
TAYLOR, EDWIN C., Pittsburgh, Pa.
TAYLOR, ERNEST W., JR., Bay City Mich.
THOGERSEN, BJORN, Camden, S. C.
TOMASIEWICZ, JOHN A., Southington, Conn.
TROUTMAN, LOUIS G., Cranford, N. J.
TURCHAN, OTTO C., Detroit, Mich.
WALKER, WOODROW W., Knoxville, Tenn.
WALSH, BERNARD C., Worcester, Mass.
WASIUTYNSKI, ANTONI E., East Orange, N. J.
WATKINS, JEFFREY, Toronto, Ont., Can.
WEAVER, THOMASON W., JR., Port Lavaca, Texas
WEBER, ROBERT W., Kokomo, Ind.
WEISENFELS, CHARLES W., Webster Groves, Mo.
WENDOVER, WILLIAM EDWARD, Hopewell Jct., N. Y.
WILLENBORG, CARL H., New York, N. Y.
WORSLEY, FRANK K., Trinidad, B. W. I.
ZIMMER, RAY R., Sausalito, Calif.

CHANGE IN GRADING

Transfers to Member and Associate

AHRENDT, WILLIAM R., W. Hyattsville, Md.
BARTLETT, JOHN M., JR., Kingston, N. Y.
BURGESS, LESLIE M., Burbank, Calif.
CARVER, VINTON D., Fort Wayne, Ind.
CERVARICH, FRANK R., Bon Air, Va.
CROUSE, EDWIN R., Chicago, Ill.
EISELE, PAUL T., Cleveland, Ohio
FALLS, EUGENE K., Downers Grove, Ill.
FIREY, JOSEPH C., Port Richmond, Calif.
FOSTER, ROBERT DONNELL, Houston, Texas
GARLAND, EDWARD J., Shrewsbury, Mass.
GIBNEY, JAMES J., JR., Schenectady, N. Y.
HAACK, DONALD J., Maysville, Ky.
HIRT, JOHN H., Monterey Park, Calif.
HOLMS, ARTHUR GLATT, Parma Heights, Ohio
HOLT, SHERWOOD G., Landenburg, Pa.
JOHANNES, EDWARD GENT, St. Louis, Mo.
JOHNSON, JOHN A., Strafford, Pa.
LANGDON, WARREN R., Scotia, N. Y.
LOEST, WILLIAM H., Gainesville, Fla.
MCCLELLAN, EDWARD A., New Orleans, La.
OLSON, ROBERT L., Whittier, Calif.
PARKER, RICHARD E. B., Huntingdon Valley, Pa.
PENTZ, NORBERT E., Chicago, Ill.
PERKINS, ROBERT L., St. Paul, Minn.
PETERSON, ROBERT N., Wilmington, Del.
QUINNELLY, JAMES LESLIE, Aberdeen, Md.
ROBERTS, GEORGE S., Baton Rouge, La.
ST. EVE, EDWARD J., University City, Mo.
SCHWEIGHOFER, HORST M., Cedar Rapids, Iowa
SETZEKORN, GENE M., Elmhurst, Ill.
SHARKEY, JOSEPH F., Newark, N. J.
SHEARER, JESSE LOWEN, Belmont, Mass.
STARKMAN, ERNEST S., Berkeley, Calif.
THOMAS, JOHN HARPER, Norman, Okla.
TSE, FRANCIS SING, Columbus, Ohio
VAN WEZEL, MYNDERT, Curaçao, Netherlands W. I.

Transfers from Student Member to Junior 430

Obituaries

Philip Fazio Ballinger (1883–1953)

PHILIP F. BALLINGER, chief engineer, Department of Air Force, Air Installations, Hunter Field, Savannah, Ga., died April 11, 1953. Born, Keokuk, Iowa, Jan. 28, 1883. Education, ME and EE, Cornell University, 1904. Mem. ASME, 1945.

Rollo Kimball Blanchard (1886–1953)

ROLLO K. BLANCHARD, retired vice-president, Neptune Meter Co., New York, N. Y., died April 25, 1953, while vacationing in Clearwater, Fla. Born, Barre, Vt., Feb. 27, 1886. Parents, Adelbert C. and Velma (Cheyney) Blanchard. Education, Dartmouth College; ME, Cornell University, 1910. Married Betty Cutler, 1918. Jun. ASME, 1912; Assoc-Mem. ASME, 1914; Mem. ASME, 1925. Served the Society on Committee on Fluid Meters; during World War II, member, Engineers' Advisory Committee to U. S. War Production Board (representing ASME). Held patents on various developments of liquid measuring devices; author of several technical papers on water works. In 1942 he received the George W. Fuller Award from the American Water Works Association. Survived by a daughter, Mrs. Robert T. Bower, Washington, D. C.; and two sons, R. Kimball, Greenwich, Conn., and Harry C., Westport, Conn.

Charles Wells Brooks (1913–1953)

CHARLES W. BROOKS, sales engineer, Hewitt-Robbins, Inc., New York, N. Y., died March 1, 1953, at his home, Brookview Farm, Moscow, Pa. Born, Scranton, Pa., Jan. 13, 1913. Parents, George G. and Grace (Williams) Brooks. Education, Hotchkiss School; BS, Yale University, 1935. Married Honour Souther, 1936; children, Tristam A., Colin S., Michael C. He held U. S. Patent on diesel injector. Jun. ASME, 1935.

Ralph Day Bryan (1888–1953)

RALPH D. BRYAN, mechanical assistant to chief mechanical officer, Atchison, Topeka & Santa Fe Railway Co., Chicago, Ill., died April 3, 1953. Born, Holden, Mo., Aug. 16, 1888. Education, high-school graduate, 1905. Mem. ASME, 1948.

John Cyriacks (1907–1952?)

JOHN CYRIACKS, production engineer, Farrel-Birmingham Co., Inc., Stonington, Conn., died about a year ago, according to a report recently received by the Society. Born, New York, N. Y., Feb. 28, 1907. Education, ME, Stevens Institute of Technology, 1930. Mem. ASME, 1946.

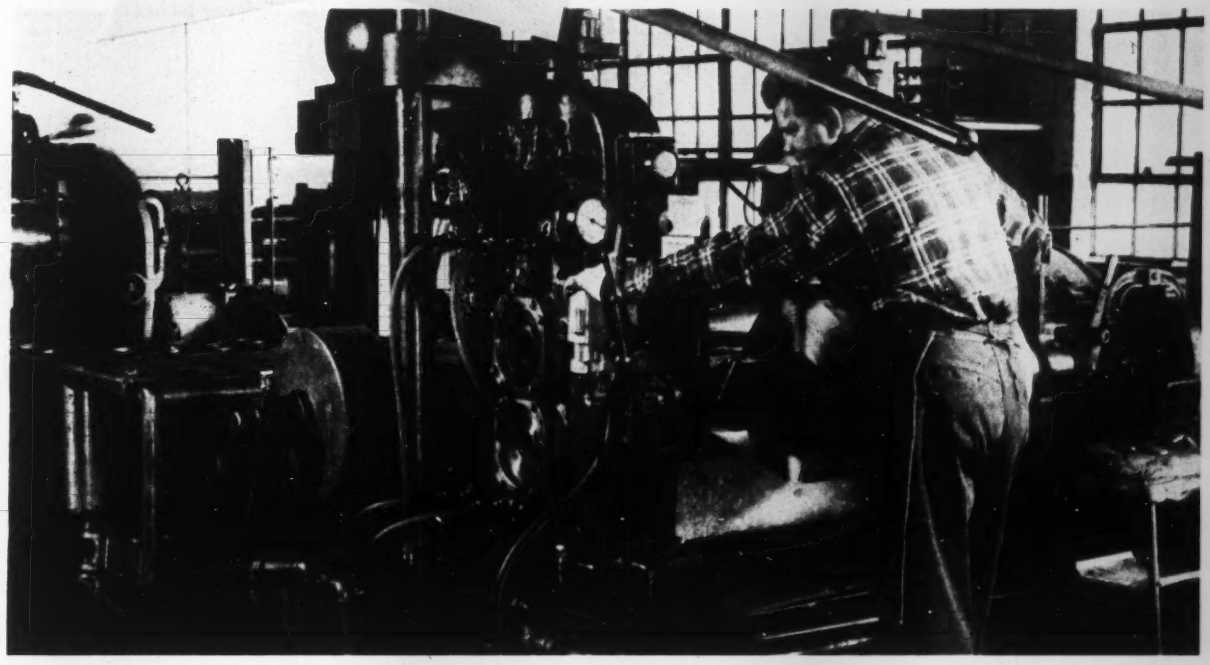
Gano Dunn (1870–1953)

GANO DUNN, president, J. G. White Engineering Corp., New York, N. Y., and chairman of the trustees of Cooper Union for Advancement of Science and Art, died April 10, 1953. Born, New

(*ASME News continued on page 610*)

Let AIR do the work!

ON THIS ALUMINUM MILL at the Baltimore plant of Crown Cork and Seal Co., tension is regulated by controlling the input speed of aluminum foil. It is done with a pneumatic brake applied to the feed roll. Air pressure to the brake is controlled with a Westinghouse Flexair® Pressure Control Valve. Since this pneumatic system was installed scrap losses have dropped about 2%, while production has increased 15%.



Three valves, some pipe, and three brakes save 40,000 lbs. of aluminum a year

You know those little protective discs of aluminum foil under many "Crown" bottle caps? At the big Baltimore, Maryland, plant of Crown Cork and Seal Company, they roll and punch 2,000,000 lbs. of aluminum foil a year just to supply those discs.

It's precision rolling too. With a tolerance of only 1/10,000″ on the final thickness. To maintain this hair-splitting accuracy, pneumatic tension control has been installed on all three of Crown Cork and Seal Company's rolling mills. It replaces manual control.

Off-size scrap losses have been reduced at least 2%; that's 40,000 lbs. of aluminum a year. At the present price of foil, this saves *$18,000*—several times more than the cost of the pneumatic systems. In addition, production has been stepped up about 15%.

This simple pneumatic system, built around Westinghouse Air Brake controls, *automatically maintains* the correct air pressure. Operating 16 to 20 hours a day for the past year, it has proved to be completely reliable.

Our experienced engineers will be glad to help you design a pneumatic control system for your equipment. Just drop us a line.

Westinghouse Air Brake
COMPANY

INDUSTRIAL PRODUCTS DIVISION **WILMERDING, PENNA.**

FACTORY BRANCH: EMERYVILLE, CALIF. **IN CANADA: CANADIAN WESTINGHOUSE CO., LTD., HAMILTON, ONTARIO**

York, N. Y., Oct. 18, 1870. Parents, N. Gano and Amelia (Sillick) Dunn. Education, BS, College of the City of New York, 1889; MS, 1897; EE, Columbia University, 1891 (he received the first EE degree ever awarded in the United States); hon. MS, 1914; hon. DS, 1938; hon. DS, Rutgers University, 1938; hon. DS, New York University, 1941; hon. DE, Lehigh University, 1942; hon. DS, CCNY, 1947; LLD, Bowdoin College, 1947. Married Julia Gardner Gayley, 1920 (died 1937). He was awarded CCNY Townsend Harris Medal, 1933; AIEE Edison Medal, 1937; Hoover Medal, 1939; Columbia University Egleston Medal, 1939; NAM Modern Pioneer Award, 1940; Pan-American Society Medal, 1947; Peter Cooper Medal, 1950; and decorated with the Order of Honor and Merit, Republic of Haiti, 1940. He contributed various papers on electrical and general engineering subjects. Mem. ASME, 1911; Fellow ASME, 1941; Hon. Mem. ASME, 1944. From 1913 to 1916 he was president of UET; 1915-1916, chairman, The Engineering Foundation. He was a U. S. delegate and member, Executive Committee, World Power Conference, 1936. Survived by two brothers, Cleveland A. and Harry A.

John Antonius Fransema (1886–1953)

JOHN A. FRANSEMA, consulting engineer, San Francisco, Calif., died March 13, 1953. Born, Godlinze, The Netherlands, Nov. 30, 1886. Parents, Ekke and Hildegonda Alida (Venhuys) Fransema. Education, high-school graduate, Leyden; The Hague, 1903; CE course, Delft Technical University, 1903–1909. Naturalized U. S. citizen, Chicago, Ill., 1917. Married Hendrika Klaasen, 1910. Mem. ASME, 1938. Survived by wife.

Gerald Blenkiron Gould (1889–1953)

GERALD B. GOULD, president, Fuel Engineering Co. of New York, and partner, Gould, Henderson & Brunjes, died March 20, 1953. Born, Detroit, Mich., July 2, 1889. Parents, William S. and Edith L. (Blenkiron) Gould. Education, BA, Yale University, 1910; MA, University of Pennsylvania, 1911. Married Anna Curtiss, 1915; children, Barbara, Gregory. He was author of many technical papers and two books, "Judging Coal Values," "Steam Generation Steps Ahead." Mem. ASME, 1931. He served the Society as chairman, Joint AIME-ASME Committee on Fuel Values, 1934–1941; AIME-ASME Coal Testing Code.

George Tewksbury Johnson (1885–1953)

GEORGE T. JOHNSON, member board of directors, The Buckeye Steel Castings Co., Columbus, Ohio, died March 11, 1953. Born, Portsmouth, Ohio, July 23, 1885. Parents, Albert T. and Margaret F. (Tewksbury) Johnson. Education, ME, Cornell University, 1906. Married Esther D. Sharp, 1909 (died 1930); children, George T., Albert T., Jane (Mrs. R. D. Webster). Married 2nd, Florence (Jeffrey) Rogers, 1942. Assoc. Mem. ASME, 1914; Mem. ASME, 1922. He was awarded several U. S. Patents on various details of freight-car trucks and draft-yoke designs; coinventor of a six-wheel truck for freight-car service. He was an honorary member, Steel Founders' Society of America.

Forrest J. Keeler (1886–1952)

FORREST J. KEELER, heating and ventilating supervisor, Board of Education, Los Angeles, Calif., died May 30, 1952, according to a report recently received by the Society. Born, Galva, Ill., April 13, 1886. Education, graduate, Galva High School, 1904; completed heating and ventilating course, ICS, 1909. Mem. ASME, 1947.

Martin W. Keller (1884–1953)

MARTIN W. KELLER, vice-president in charge of manufacturing, Oneida, Ltd., Oneida, N. Y., died April 20, 1953. Born, Lime Rock, Pa., Sept. 13, 1884. Education, graduate, Pennsylvania Business College. Assoc. ASME, 1919. Survived by wife, Mabel W. Keller, and a son, John R.

Robert Anthony Minch (1919–1953)

ROBERT A. MINCH, project engineer, Zanesville plant of Shellmar Products Co., Mt. Vernon, Ohio, died March 5, 1953. Born, Columbus, Ohio, Dec. 9, 1919. Parents, Fred S. and Martha J. (Smith) Minch. Education, ME, Ohio State University, 1949. Jun. ASME, 1949. Survived by wife, Bernadine; and three children, Robert, Barbara, Martha.

Lewis Ferry Moody (1880–1953)

LEWIS F. MOODY, professor emeritus of hydraulic engineering, Princeton University, and inventor of many patented improvements in hydraulic turbines, pumps, and accessories, died April 18, 1953. Born, Philadelphia, Pa., Jan. 5, 1880. Parents, Carlton M. and Elizabeth E. (Lewis) Moody. Education, BS, Towne Scientific School, University of Pennsylvania, 1901; MS, 1902. Married Eleanor C. Greene, 1909 (died 1937). Mem. ASME, 1910; Fellow ASME, 1944; Hon. Mem. ASME, 1951. He served the Society as director at large, 1946–1948; chairman, Philadelphia Section; chairman, Executive Committee, and one of the founders, Hydraulic Division; member, Power Test Codes Committee. In 1945 he was awarded the Elliott Cresson Medal by The Franklin Institute. He contributed many papers to the publications of the engineering societies and was the author of several textbooks. During his career he played a major role in developing and increasing the efficiency of the Kaplan propeller turbine. With more than 90 patents, he extended his work to catapults for launching planes from ships, the stabilization of ships, and centrifugal pumps. Survived by two sons, Lewis F., Jr., Arthur M. G., Mem. ASME; a daughter, Eleanor L. (Mrs. E. M. Broadhurst); and a sister, Mrs. DeWitt D. Barlow.

Robert Clifford Ried (1912–1953)

ROBERT C. RIED, head of the consulting firm, R. C. Ried—Engineers, New York, N. Y., died March 27, 1953. Born, West Conshohocken, Pa., May 5, 1912. Education, BS(ME), Villanova College, 1934. Jun. ASME, 1934; Mem. ASME, 1951. Survived by wife, Ethel U. Ried; two children, Barbara J., Robert C., Jr.; his mother, Mrs. Anna Ried; and a sister, Mrs. Robert Cattermole.

Cecil Todd Spriggs (1901–1952)

CECIL T. SPRIGGS, supervising engineer, Otis Elevator Co., New York, N. Y., died June 14, 1952. Born, Arkville, N. Y., Aug. 17, 1901. Parents, Charles V. and Lillian (Todd) Spriggs. Education, ME, Rensselear Polytechnic Institute, 1922. Married Mabel E. Stevens. Mem. ASME, 1945. Survived by wife, a son, and a daughter.

Keep Your ASME Records Up to Date

ASME Secretary's office in New York depends on a master membership file to maintain contact with individual members. This file is referred to dozens of times every day as a source of information important to the Society and to the members involved. All other Society records and files are kept up to date by incorporating in them changes made in the master file.

From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information you should be registered in the Divisions (no more than three) in which you are interested. Your membership card bears key letters opposite your address which indicate the Divisions in which you are registered. Consult reverse side of card for the meaning of the letters. If you wish to change the Divisions in which you are registered, please notify the Secretary's office.

It is important to you and to the Society to be sure that your latest mailing address, business connection, and Professional Divisions enrollment are correct. Please check whether you wish mail sent to home or office address.

For your convenience a form for reporting your address, business connection, and Professional Divisions enrollment is printed on this page. Please use it to keep the master file up to date.

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JENKINS
Fig. 106-A
Renewable Composition Disc

BRONZE GLOBE VALVE

150 lbs. Steam
200 lbs. O.W.G.

Take a Jenkins Fig. 106-A apart. It's easy to see why it is industry's all-time favorite. Note the liberal dimensions of body and bonnet casting — the heavy, manganese bronze spindle, with more strong threads in contact with the bonnet, regardless of spindle position. See how the slip-on, stay-on disc holder fully protects the edge of the disc, prevents creeping, flaking, or cracking.

Every part, from perfect grip, heatproof handwheel to pipe ends, reflects the designing skill of Jenkins valve *specialists.* There's a good reason. Jenkins Bros. introduced the *first* renewable composition disc valve, — is today the only manufacturer of both valves *and* discs.

Fig. 106-A not only looks better — it proves out better in performance. In any comparison, its long life, low upkeep record has never been surpassed. That is the true measure of valve cost — and it is the reason why industry's shrewdest buyers will settle for nothing less than Fig. 106-A quality.

JENKINS VALVES

LOOK FOR THE DIAMOND MARK

SINCE 1864 TRADE JENKINS MARK

Jenkins Bros

GET THIS FOLDER — Gives details of Fig. 106-A design, and "family" interchangeability. Ask your Jenkins Distributor for Form 189-A, or write Jenkins Bros., 100 Park Ave., New York 17.

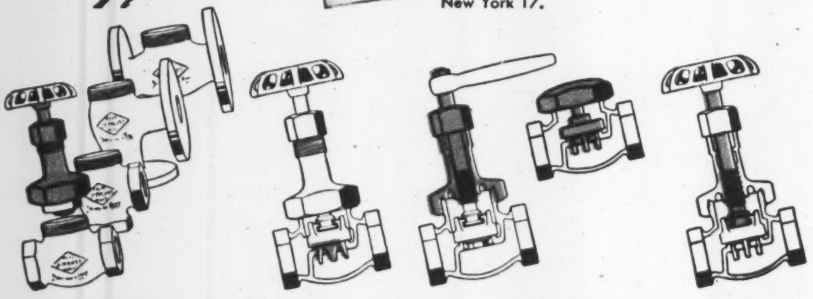

Fig. 106-A "Family" Interchangeability meets 90% of your valve needs with a small inventory of parts. Start with the standard Fig. 106-A. Trimming is interchangeable in Globe or Angle body, screwed or flanged. With a few parts, quickly-assembled combinations provide a Lift Check, a Spring-loaded Check, and valves for Stop and Check, Quick-opening, or Throttling service.

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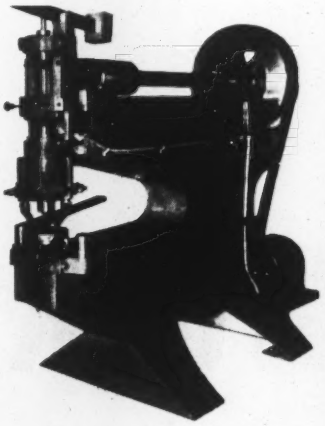
Available literature or information may be secured by writing direct to the manufacturer. Please mention MECHANICAL ENGINEERING

Nibblers

Tabor-Gray Turret Head Nibblers will cut practically all alloys without distortion, reports the manufacturer, The Tabor Mfg. Co., 6225 Tacony St., Philadelphia 35, Pa. The company says also that cutting accuracy applies even for shapes from high alloys up to $^1/_2$ in. in thickness and milder alloys up to 1 in. in thickness, in flats, curves, irregulars, or tubing.



Illustrated is the Tabor-Gray Nibbler No. 12, with $^3/_4$-in. capacity. The full Tabor-Gray line includes machines ranging in capacity from $^3/_{16}$ in. to 1 in.

Tabor-Gray says that although the machine is primarily designed to nibble, it will also shear where a reasonable amount of distortion is no factor.

Air-Cooled Diesel Engine

A two-cylinder, air-cooled Diesel engine, the Model AC2, is now in production by the Hallett Mfg. Co. The engine has a four-stroke cycle, $3^1/_2$-in. bore and $3^3/_4$-in. stroke, and 36.07 cu in. displacement per cylinder. Thirteen hp, continuous operation or 14 hp, intermittent, are developed.

The engine has an integral flywheel blower, and a 20-to-1 compression ratio. Weight, complete, is 350 lb. Any clean grade of distilled Diesel fuel oil, 28 to 45 API gravity, cetane No. 36 or better, is suitable; this includes such commercial fuels as standard diesel, automotive diesel, heavy diesel, common kerosene, Chevro-Jet, and JP-4 jet-engine fuel.

Standard equipment is hand crank, oil bath air cleaner, fuel oil filter, operating instructions, and fuel oil transfer pump. Optional equipment is electric starting system, accessory drive equipment, and several cold-weather starting aids.

Automatic Bar Machines

New Warner & Swasey $1^1/_4$-in. and $^3/_4$-in. automatic bar machines extend into a smaller size range the rapid set-up and precision working features of the company's larger models introduced in 1947, according to a company announcement. The new machines incorporate the same quadrant mechanism which eliminates changeable cams. Feed strokes are set by positioning trip blocks on calibrated quadrant scales, and the same principle is applied to the cross-slide feeds.

The machines also use elliptical-eccentric gears to power the Geneva indexing mechanism. Provision is made for over-indexing of the spindle drum, at which point a latch drops into position and a toggle-operated locking slide back-indexes the drum about $^1/_{16}$ in. against the latch.

The new high-speed automatics are equipped with six spindles in contrast with five on the larger Warner & Swaseys. These have a speed range of 255–2781 rpm in the $1^1/_4$-in. bar capacity model, approximately twice that of the $1^3/_4$- and $2^1/_4$-in. machines. The new $^3/_4$-in. bar machine has a higher range, 372–4045 rpm. Working dimensions are similar to those of the larger automatics. Turning stroke is infinitely variable between 0–5 in.; maximum length turned, with multiple cuts, is $8^1/_2$ in. standard, up to 10 in. special. Bar feed stroke is infinitely variable up to 10 in., cross-slide stroke between $0–^{13}/_{16}$ in.

The machines are powered by a 20-hp, 1750-rpm motor, with drive-shaft speeds of 916 rpm ($1^1/_4$-in. model) and 1333 rpm ($^3/_4$-in. model). Coolant capacity is 120 gal, free circulation reservoir capacity 7 gal, and lubrication reservoir capacity 6 gal.

The machines are 11 ft 2 in. in overall length and 4 ft 6 in. wide. Net weight of the standard machine is 13,900 lb. A continuous clip conveyor, which moves clips out of the pan through the rear of the machine and deposits them in a portable bin, is standard equipment on W & S multi-spindle automatics. More information is available from the company at 5701 Carnegie Ave., Cleveland 3, Ohio.

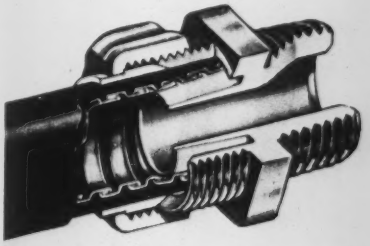
Water Suction Hose

A horizontal-braided water suction hose, Revolc Water Suction Hose, has been developed by Quaker Rubber Corp. Div. of H. K. Porter Company, Inc., Philadelphia, Pa.

Revolc Water Suction Hose is designed for both pressure and suction handling of water. The hose is reinforced with two layers of braided rayon cord, plus a helix of high-tensile spring-steel wire. The layers of reinforcement are separated by a layer of rubber friction to eliminate internal chafing of the reinforcing cords and wire. The hose is available in $1^1/_4$-in. to 3-in. inside diameter sizes.

Liquid-Tight Conduit Fitting

A new fitting for liquid-tight flexible conduit mates with any conduit spiral and doesn't have to be taken apart when installed, according to its manufacturer, The Thomas & Betts Co., Elizabeth, N. J. The fitting is said to be ideal for machine tool wiring or other similar electrical circuits exposed to corrosive liquids and mineral oils. It is made in straight, 90-deg and 45-deg elbow designs and accommodates conduit from $^3/_8$ to 2 in. trade size. The new design was developed with the cooperation of the Metal Hose Div., American Brass Co.

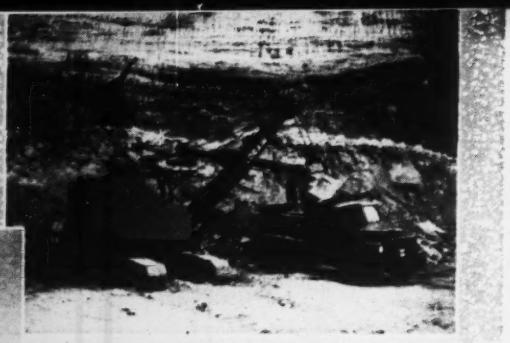


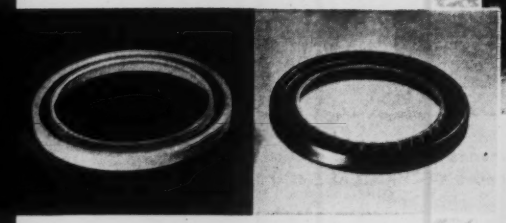
Another advantage claimed for the fitting is the fact that only one wrench size is needed for the gland and the body. A color-coded plastic seal in the gland indicates a fitting's size and that it is a liquid-tight type. When the colored seal is visible after installation of the fitting, the raceway is properly grounded. The end of the fitting facing the junction box has sufficient length to accommodate double locknuts used with sheet metal boxes, the company says. It also points out that tapered pipe threads provide a liquid-tight connection with cast-iron boxes. The fitting's body is die cast from zinc alloy for the three smallest straight sizes. Other sizes are of malleable iron.

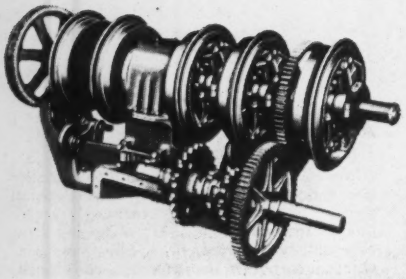
Hydraulic Motors

Vickers Inc. has announced production of two new sizes of vane motors, Series M2-300 and M2-400. The new motors supplement the previously released Series M2-200 and M2-500 units and complete the range from 5 to 28.5 hp.

Features of the motors are automatic pressure loading, automatic adjustment of both radial and axial clearances, and maintenance of a lubricating oil film on both rotor faces and vanes. Mounting adaptability is provided by four combinations of inlet-outlet port position, by a choice of face, flange, or foot mounting and of either direct, belt, chain or gear drive. Series M2-300 motors are available in 7.7-, 10.2-, and 12.8-hp output sizes, and Series M2-400 motors in 16.6- and 21.6-hp sizes. Further information is contained in Bulletin M-5103, available from Vickers Inc., 1500 Oakman Blvd., Detroit 32, Mich.







SILASTIC*
Keeps Clutch Shaft Bevel Gears of Lorain TL-25's Bathed in Oil

Silastic lip seals look as good as new after more than 5 years of rugged service on the oil-filled clutch shaft bevel gear housing on the Thew-Lorain model TL power cranes and shovels. Conventional rubber seals failed frequently at operating temperatures in the range of 250°F. Silastic's long service life substantially reduces maintenance costs and production losses.

Performance proves...

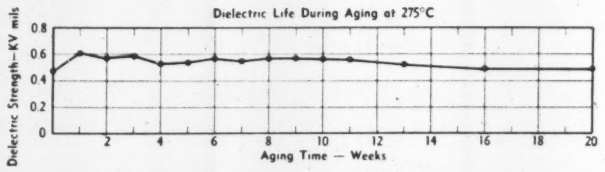
SILASTIC works

where other materials fail!

The turntable is the "guts" of a power crane or shovel, the part that makes the "wheels-go-round", where profit-making performance begins, so it's not surprising that Thew-Lorain put Silastic to work in the TL-25's, their newest idea in turntable design.

Silastic has been performance-proved in thousands of mechanical and electrical applications. It retains its rubbery properties at temperatures ranging from —70 to above 500°F; shows excellent resistance to shock, vibration, oxidation, weathering, and to a wide variety of hot oils and chemicals.

And Silastic stocks for electrical applications are unique even among silicone rubbers for low water absorption and retention of dielectric properties and high physical strength after long aging at Class H temperatures. Proof of the inherent stability of Silastic is given in the graph showing the effect of aging at 275°C (527°F) on the dielectric strength of Silastic.



When you need rubbery properties at temperatures above or below the limits of organic rubbers, or good dielectric properties in a resilient and flexible material, ***specify SILASTIC.***

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NEW EQUIPMENT
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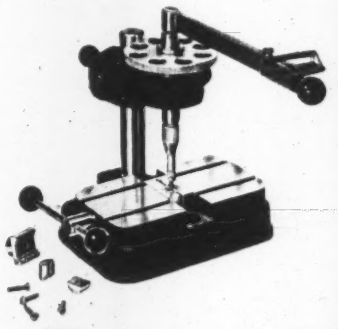
Torque Testing Fixture

The P. A. Sturtevant Co., Addison, Illinois, manufacturer of torque wrenches, has announced a new Torque Testing Fixture. An adjustable spindle set in instrument bearings is held in rigid alignment and permits rapid engagement of the driver with the work. The spindle has a female drive square to accommodate a selection of torque wrenches within the capacity of each of the two models. The driving end of the spindle is threaded so that users may design drivers for special applications. A standard male drive square attachment is included with each fixture and is fitted to the driving end of the spindle. This permits using regular sockets, socket screw drivers, etc., without alteration, according to Sturtevant engineers.



Illustrated is a typical application of testing the ultimate strength of a screw. Internally threaded collets, collet holder, and drivers for all screws are available for use with these fixtures. There are two models of the Torque Testing Fixture now in production, with capacities of 0 to 200 in.-lb and 0 to 150 ft-lb. Bulletin TTF, giving complete specifications and suggestions for use, is available on request.

Lift Trucks

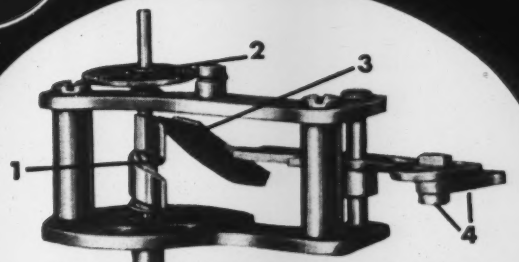
Two completely new fork lift trucks in capacities of 3000 and 4000 lb have just been released, according to a recent announcement of the Hyster Co. They are the Models YC-40 and UC-30, powered by heavy-duty, water-cooled industrial engines and mounted on cushion-type tires. Outstanding features are said to be their extreme compactness, durability, and maneuverability.

The YC-40 has a capacity of 4,000 lb at 24-in. load centers. Its width of only 38 in. and overall length of 78½ in. permit it to operate inside of boxcars and in crowded quarters. Its collapsed height of 82½ in. permits it to pass through ordinary doors and under low ceilings. The load can be raised 30 in. before the minimun height is affected. The YC-40 will climb a 20 per cent grade loaded or empty.

The UC-30 is basically the same truck as the YC-40, but with 600 lb less counterweight and a capacity of 3,000 lb at 24-in. load centers. The overall length is 74⅜ in. and it will climb a 24 per cent grade loaded or empty. Both trucks have a turning radius of 75 in. and 30 in. of free lift on the standard 9-ft uprights. Literature and specifications are available at any Hyster dealer or by writing Hyster Co., Portland 8, Ore.

ACCO products

HELICOID GAGES



FOUR HELICOID FEATURES

1. Stainless Steel Helicoid Roller (no gear teeth)
2. Stainless steel hair spring
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Why HELICOID Gages...

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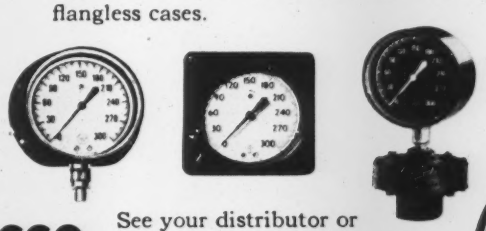
NO GEARS, NO TEETH

● HELICOID is the greatest achievement of the gage makers' craft—the pressure or vacuum gage *without gears... without teeth!* The HELICOID movement is a simple cam and roller device that gives long, trouble-free service. It has been tested and proved in years of hard service in the field.

HELICOID Gages are particularly desirable where pressures fluctuate and cause excessive movement and wear of gears in ordinary gages. The smooth operation of the durable HELICOID cam and stainless steel roller keeps the pointer as steady as it was originally even after hundreds of thousands of cycles.

Many sizes, many styles

You can get HELICOID Gages for pressure, vacuum, or compound service—in all pressure ranges; white, black, or radiant faces; wall, stem, flush, and panel mountings, or flangless cases.



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MORE MATERIAL
MORE EXPERIENCE
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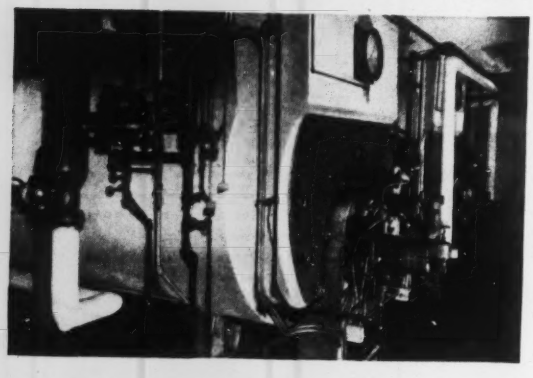
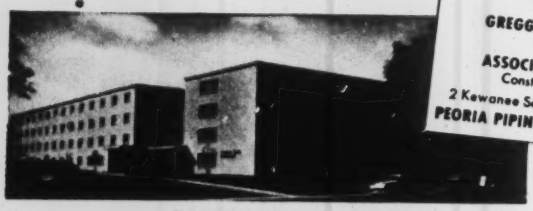


KEWANEE
STEEL BOILERS

Wherever Heat or Power or Industrial Process Steam is required there is a Kewanee Boiler just right for the job. And into every Kewanee goes *more of everything* that adds to a boiler's life and makes it most economical. Owners *expect more* from Kewanee Boilers . . . and they *get more.*

Pictured is a battery of two Kewanee Scotch-type Boilers, for low pressure in the boiler room of the Men's Dormitory, Bradley University . . . a Kewanee series which "stands on its own legs," needing no special setting and requiring comparatively little floor space or head room.



Men's Dormitory
BRADLEY UNIVERSITY
Peoria, Illinois
GREGG-BRIGGS & FOLEY
Architects
ASSOCIATED ENGINEERS
Construction Engineers
2 Kewanee Scotch Boilers installed by
PEORIA PIPING & EQUIPMENT CORP.

KEWANEE-ROSS CORPORATION
Division of American Radiator & Standard Sanitary Corporation
KEWANEE, ILLINOIS

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Steam-Condensate Corrosion Preventive

Corrosion in steam condensate systems resulting from the presence of oxygen and acid carbon dioxide now can be effectively controlled by use of a film-forming amine, Hagafilm, fed to the boiler in small amounts on the order of two to three pounds per million pounds of steam, Hagan Corp. has announced.

Hagan Corp., Pittsburgh, Pa., is announcing Hagafilm and describing its advantages with a bulletin available to boiler plant operators and executives. Grooving and pitting by corrosive condensate create numerous difficulties, the bulletin points out: pipe failures and plugging of traps, valves, meters, pumps, and even return lines. Deposits resulting from corrosion frequently cause serious reduction in heat-transfer efficiency. Iron oxide carried back to the boiler with feedwater increases the likelihood of failure in boiler tubes.

Hagafilm, fed to the boiler, vaporizes with the steam and deposits a very thin, non-wettable protective film on all metal surfaces wherever condensation occurs and throughout the return system, Hagan explains. Problems arising from condensate corrosion are thus minimized. If only part of a return system needs this protection, the Hagafilm may be injected into the appropriate branch steam line. There is no danger in handling or use, the bulletin points out. The material is supplied in both solid and liquid form. The solid is readily mixed with hot condensate to make a dispersion for feeding. The ready-mixed liquid emulsion may be more convenient for some boiler plants, particularly where needs are relatively low. For convenience in using Hagafilm in either large or small steam-generating plants, Hagafilm is supplied as a solid in 55-lb drums, and as an emulsion in 55-gal drums (400 lb net) and 5-gal cans (40 lb net). Copies of the new Hagafilm bulletin may be obtained from Hagan Corp., Hagan Bldg., Pittsburgh 30, Pa., or from district representatives of Hagan or an associated firm, The Buromin Co.

Leak-Detection Service

A custom leak-detection service is now offered by the Analytical Service Dept. of Consolidated Engineering Corp., Pasadena, Cal. The service is designed for tests of either vacuum or pressure prototypes, development models, pilot models, laboratory equipment, etc. Employed, in conjunction with a Consolidated 24-101A Leak Detector, is a ten-port vacuum manifold capable of testing nine samples simultaneously, comparing leakage to a standard leak of 5×10^{-7} atmosphere cc/sec. This standard conforms with government leak specifications of 0.1–0.01 micron ft per hr. Detected leaks are located, quantitatively measured, and reported.

Inert, non-contaminating helium is used as a probe gas, and its passage through the leak in parts or equipment under test is detected by the Consolidated 24-101A Leak Detector, a simplified portable mass spectrometer sensitive to minute traces of helium. Liquids or corrosive, toxic, or explosive materials are not used.

Further information may be obtained by writing Manager, Analytical Service, Consolidated Engineering Corp., 300 North Sierra Madre Villa, Pasadena 15, Cal.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Oil Filtration Filter

A portable cartridge filter, for cleaning hydraulic, quench, and other oils, has been placed on the market by the Industrial Filtration Div., U. S. Hoffman Machinery Corp., 219 Lamson St., Syracuse 6, N. Y.

Developed to bring filtration to the machine (or machines) which otherwise might not get such protection, the new Hoffman unit is designed for one-man handling. Flexible hose and couplings permit the operator to hook up to the oil supply of the machine without interrupting its operation. The unit operates on a recirculation basis for such time as is required to recondition the oil.

Applications for the unit, as cited by the Hoffman announcement, are hydraulic presses, hydraulic machine tools, injection-molding machines, die-casting machines, hydraulic scrap-balers, and quench-oil tanks. In each case it is claimed that operation of a portable cartridge filter will pay for the unit by avoiding serious damage and repairs resulting from abrasive action of solid particles.

Two models of the new Hoffman are being furnished, one for 30-gph pump capacity and the second for 60-gph pump capacity. Both can be supplied for either repackable or throw-away type cartridges and for either Fuller's earth or cellulose re-fills. Details and specifications are contained in new Bulletin A-916 obtainable by writing Industrial Filtration Div., U. S. Hoffman Machinery Corp.

Armco Builds New Hot Strip Mill

A huge new $40 million hot strip mill has been placed in service at Armco Steel Corp.'s Ashland, Ky., plant, where both the newest and the oldest continuous steel rolling mills in the world are located in the same plant.

Under construction for over two years, the new 80-in. mill is said to be the most modern of its kind in the world. It will roll 10-ton steel ingots into thin strips of steel hundreds of feet long in a continuous process. The mill is housed in a building almost a half-mile long, and has a capacity of 150,000 tons of finished sheet steel a month, enough for 133,000 new automobiles.

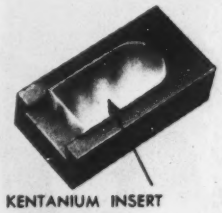
Thirty years ago, according to the company, Armco developed the continuous rolling process at its Ashland plant, and the basic facilities of that original mill are still in operation. Prior to 1924, sheet steel was made on slow-producing hand mills. With the advent of the continuous method, production multiplied almost overnight as continuous mills were constructed by major sheet steel producers in the United States and abroad.

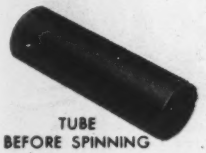
Armco's overall expansion program at its Ashland plant will cost $47 million. Although the major portion of the program has now been completed, construction is continuing on facilities for processing light gage steel. These include a continuous pickling line for removing oxides that form on the steel during rolling; a cold reversing mill which rolls strips of cold steel into even thinner gages; and light and heavy gage Zincgrip lines to coat strip steel with zinc in a continuous process.

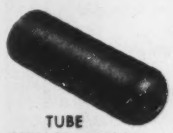
Use a CLASSIFIED ADVERTISEMENT
For QUICK RESULTS

Outlasts 30 Tungsten Carbide Tools . . . When the HEAT (plus ABRASION) . . is On!

What's Your HOT Design Problem?


KENTANIUM INSERT


TUBE
BEFORE SPINNING


TUBE
AFTER SPINNING

This is a typical example of how industry effectively uses heat-resistant Kentanium to improve product performance under conditions of high temperature combined with oxidation and severe abrasion. Spinning the ends of hot steel tubing destroyed tungsten carbide tools in an average of 4 hours. Tools made of Kentanium last 15 hours before facing is necessary—and can be refaced up to 8 times per tool.

If improvement of your product or process involves high temperature conditions, especially where abrasion and oxidation are factors, investigate Kentanium. It is our exclusive development chiefly titanium carbide (small percentages of other refractory metal carbides), with nickel "binder".

Great strength at temperatures up to 2200°F, and extreme resistance to abrasion, oxidation, and thermal shock are Kentanium's combination of features that cannot be obtained in any other known material. Weighs only ⅔ as much as steel; has hardness up to 93 RA; uses neither tungsten nor cobalt.

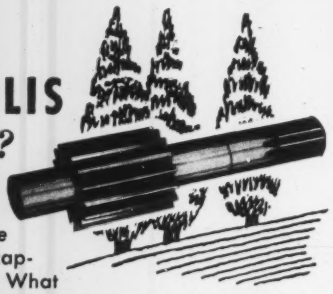
Kentanium is available in standard extruded shapes, simple molded forms, and intricate designs. Our engineers are available to work with you to apply it effectively to your high temperature problem.

An Exclusive Development of KENNAMETAL® Inc., Latrobe, Pa.

KENTANIUM

HEAT-RESISTANT, HIGH-STRENGTH, LIGHTWEIGHT
CEMENTED TITANIUM CARBIDE

what does
THUJA OCCIDENTALIS
have to do with gears?



Thuja occidentalis is a type of cedar tree —of which there are many in the landscaping around our modern, attractive plant. What do they have to do with making gears? Indirectly, a lot; because they contribute a lot to making our plant a desirable and attractive place for our expert craftsmen to work. Pleasant surroundings, we believe, are of major importance in helping our employees produce the highest quality work they are capable of. Thus our Thuja occidentalis is one of the many details we've considered in our efforts to bring you better custom gears. If you're not already a Cincinnati Gear customer, inquire today for full information.

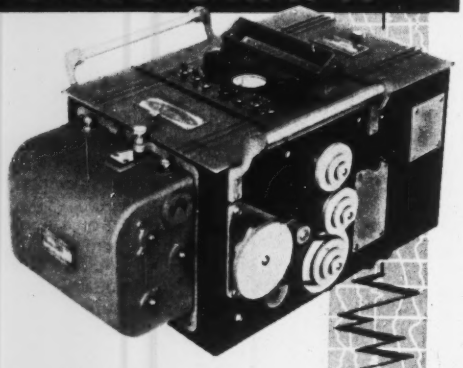
SPUR
WORM
INTERNAL
SPIRAL BEVEL
HELICAL
HERRINGBONE
*CONIFLEX BEVEL
SPLINE SHAFT

*Reg. U. S. Pat. Off.

THE CINCINNATI GEAR COMPANY
"Gears . . . Good Gears Only"
Wooster Pike and Mariemont Ave. • Cincinnati 27, Ohio

THE NEW
'Economy' OSCILLOGRAPH

Long the world's most popular oscillograph, the Type S-14 has been redesigned and improved to meet exacting demands of modern research. The NEW Type S-14C 'Economy' Oscillograph is the simplest to operate and maintain, and the most versatile in application. No research or testing laboratory is complete without it.



- Wide range of galvanometer types and characteristics. Natural frequencies to 10,000 cps; sensitivities to 50,000 mm per ma; single and polyphase watts.
- Precision optical system for very high writing speeds and high-quality records.
- Continuous-drive magazine for records to 100 or 200 feet long.
- Wide range of record speeds. Any of 9 speeds available by shifting single external belt. Standard speeds: 40, 20, 10, 4, 2, 1, 0.4, 0.2 and 0.1 in./sec.
- Internal motor and gear reducer shock mounted and vibrationless.
- Light-socket operation.
- Daylight loading and unloading.
- Automatic transiend recording attachments.
- Complete list of accessories for extreme versatility.

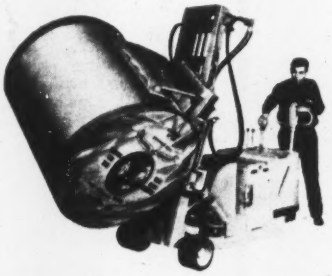
FOR FURTHER INFORMATION WRITE FOR BULLETIN 2N1

Hathaway
INSTRUMENT COMPANY
1315 SO. CLARKSON STREET • DENVER 10, COLORADO

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Roll Handling Attachment for Electric Trucks

A roll-handling attachment for the "Walkie"-type electric truck in the Powrworker line has been announced by the Clark Equipment Co., Battle Creek, Mich. The attachment picks up rolls of newsprint, fibre board, fabric, or any product in rolls, from either vertical or horizontal positions, in and out of storage to a height of 130 in. Hydraulic clamps handle rolls varying in diameter from 24 to 42 in. and weighing up to 2000 lb.



Electric controls are located near the operator for clamping, rotating, hoisting, lowering, and tilting. The attachment is especially suited for work in congested areas or where aisle space is at a premium, the company says. It is not available for export. Additional information can be obtained from the Clark Equipment Co., Powrworker Sec., Buchanan, Mich.

Extension Indicator

A new Extension Indicator for measuring extension under load in tension test specimens and automatically controlling auxiliary devices, has been announced by Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa. The instrument is applicable to any type testing machine in conjunction with any standard high-magnification Microformer-type extensometer of any gage length. Microformer is a miniature variable transformer with a movable core.

The Extension Indicator delivers signals at preset values of extension. Signals are visual (lamp), audible (buzzer), and electrical, closing relay contacts and actuating an auxiliary device such as a load holder, load indicator, load printer, or other device. Automatic printing of load values is under development. On certain Baldwin testing machines the load-indicating pointer can be held momentarily on signal to facilitate reading load at the desired extension.

The instrument is essentially a balancing Microformer actuated through an electronic amplifier under the control of the extensometer Microformer. Only control on the instrument is a dial graduated in tenths of 1 per cent extension up to 0.7 per cent by means of which the signals can be set for the desired extension. The dial is geared to the balancing Microformer armature in such a way that dial rotation is proportional to extension within the gage length of the extensometer. The indicator operates on standard 110–120-volt a-c lines.

A portable cabinet approximately 10 × 10 × 10 in. contains the instrument and extension cables. Weight totals 22 lb.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Variable-Speed Motor

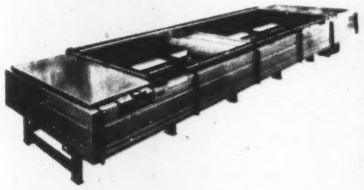
Fractional-horsepower Varidrive motors in combination with right-angle Syncrogears are now available through a new development of U. S. Electrical Motors Inc. Designed for applications requiring low, variable speeds with a compact, right-angle hook-up, this Varidrive-Syncrogear motor, called type VA-GW, is offered in $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, and $\frac{3}{4}$ hp with speed variations up to 10:1.

These units offer maximum compactness and suitability to such applications as conveyors, the company declares. The full range of speeds is achieved by turning the control handle within an arc of 300 deg. Because the variable-speed transmission is of the V-belt type, speed changes as slight as 1 rpm may be effected while the motor is operating.

Features of the VA-GW include: infinite speed control, double-cog Varibelt, splined Varidisc sheaves, Autotaut tension control for permanent belt adjustment, hardened and ground worm, special bronze alloy gear, asbestos-protected windings, Lubriflush lubrication and normalized castings. For additional information concerning this motor, write to U. S. Electrical Motors Inc., Box 2058, Terminal Annex, Los Angeles 54, Cal.

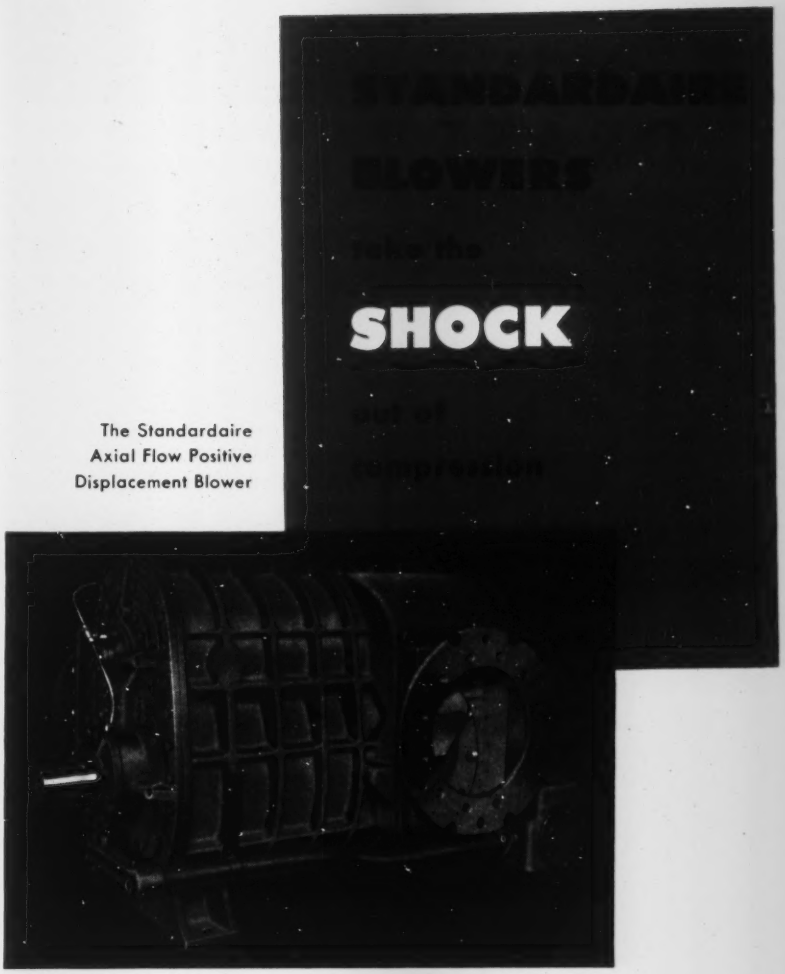
Large Vacuum Printing-Frame

A new traveling-light vacuum frame for broad industrial usage is announced by the Charles Bruning Co., Inc., 4700 Montrose Ave., Chicago 41, Ill. It is available in various sizes up to approximately 8 ft wide by 20 ft 10 in. long. The printing frame is completely self-contained, except for the lamp transformers, and has a variable-speed light source that distributes light uniformly by means of a complete focal plane sweep. All operations are performed without any manipulation of the frame proper, including tilting to a vertical position.



In recent years there has been a special demand for an extra-large-size printer by manufacturing firms for highly accurate copying work, by oil companies for their map work, and by the aircraft industry for making exact reproductions on various non-rigid and rigid materials. With this new frame it is possible to make exact reproductions of drawn parts on glass cloth, sheet metal, and other mediums that have been suitably coated. Reproductions from drawings can be made on steel plates one inch thick for dies or other forms of tooling.

The main light source is one or more quartz mercury-vapor arc lamps. The drive member is an electronically controlled, variable-speed, d-c motor with built-in worm reducer gear. The contact is established between a vacuum blanket and a plate glass. Air is exhausted from the space under the blanket by a rotary positive-displacement-type pump which establishes a contact pressure of approximately 14 psi, or one ton per sq ft.



The Standardaire Axial Flow Positive Displacement Blower

Standardaire Axial Flow Positive Displacement Blowers operate on a principle of compression unlike any other blowers. Their symmetrically generated rotors act as an air screw, drawing in and discharging air smoothly from the pockets which form between them.

Compression is gradual, completely internal and free from shock. Internal pressure is raised to equal discharge pressure before the pocket registers with the discharge port, eliminating the slap back and loading of internal parts common to many types of blowers.

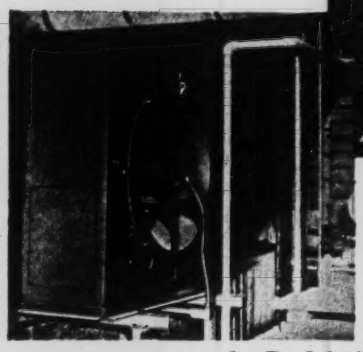
Standardaire Blowers move more air, with less wear, less maintenance and power cost than any blowers of equal weight, size or comparable design.

For further information, write:

CORPORATION

BLOWER-STOKER DIVISION
370 Lexington Avenue, New York 17, New York

Announcing
The WING Package—
DRAFT INDUCER
FOR POWER PLANTS

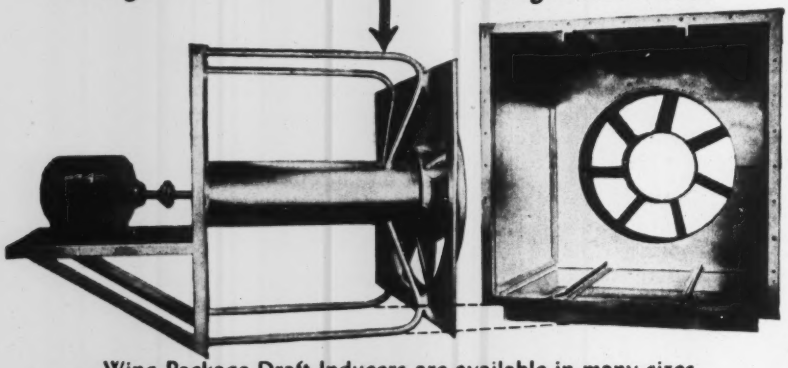


Motor (or Turbine) and Fan in one complete removable unit

In this new high-pressure "Package" Draft Inducer, the motor (or turbine) and fan unit, completely independent of the casing, makes installation considerably easier, and being easily removed, facilitates inspection and maintenance.

ADVANTAGES

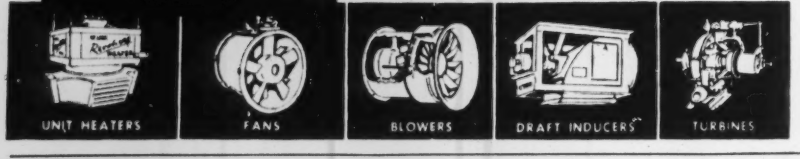
1. Big saving in space requirements
2. Compactness permits fewer and lighter structural supports
3. Eliminates field line-up problems
4. Eliminates water cooling
5. Only two supporting bearings
6. Wide flexibility in gas inlets
7. All moving parts quickly and easily accessible
8. Saves on investment and maintenance
9. Low load ratings on natural draft because of Wingfoil Fan and ample free gas travel area



Wing Package Draft Inducers are available in many sizes with either turbine or electric motor drive. For further information write

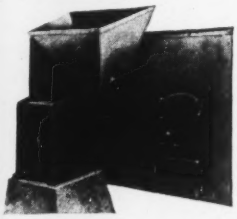
Wing

L. J. Wing Mfg. Co.
156 Vreeland Mills Road,
Linden, New Jersey
FACTORIES: Linden, N.J. and Montreal, Can.



KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Underfeed Stoker



To complete its line of single-retort Under-feed Stokers the Erie City Iron Works has introduced its "Fluid-Ram" hydraulically driven and controlled model. This compact stoker provides unobstructed access to fire doors, sifting doors, and ashpit doors, the company declares. The hydraulic fuel-feed control offers an infinite range of fuel regulation, making the unit ideal for automatic combustion control where wide load range operation is desired. Bulletin SB-47 is available for the asking from Erie City Iron Works, Erie, Pa.

Salt Brine Rust Inhibitor

Corrosion or rust in a salt brine refrigeration system is a recognized common cause of clogged spray nozzles, extra maintenance and cleaning expense, shortened equipment life, contaminated brine, and spotting of meats or other refrigerated products. A new method of controlling corrosion and rust in such facilities—unit coolers, cold-air diffusers, spray-deck refrigeration systems—has been announced by Calgon, Inc., Pittsburgh, Pa. Use of the company's rust inhibitor "Banox" in meat-packing plants, dairies, breweries, cold-storage plants and refrigeration brine systems elsewhere has indicated that it effectively stops rust action, Calgon states.

Calgon, Inc., spokesmen announced that the use of Banox in refrigeration salt brines in federally inspected meat packing plants is approved by the Meat Inspection Service of the U. S. Bureau of Animal Industry.

Advantages of Banox are claimed to be the absence of chromates, alkalies, or acids, and that it is odorless, non-poisonous, non-toxic, and harmless to the skin, eyes, clothing, paper, and paint finishes.

Details on this use of Banox are contained in a folder, "Refrigeration Salt Brine Corrosion Control with Banox," available without obligation upon request to Calgon, Inc., Hagan Bldg., Pittsburgh 30, Pa.

Dust and Fume Control

A package smoke and fume control unit has been developed by Robert E. Moyer Associates, Tenth and Union Streets, Catasauqua, Penna. Removal of dust concentrations up to 100 grains per cu ft of gas is claimed for the unit, which uses a catalyst arrangement that can remove odors produced by burning rubber, refuse, etc., and a scrubber that also reduces the exit temperature of the gases.

The unit can be supplied to handle 1000 cfm to 200,000 cfm of gas, with an inlet temperature of 2000 F to saturated temperature. Cleanout doors and a removable top are provided to give access for internal repairs and removal of deposits in the settling chambers.

The quantity of water required varies from 2 gpm to 200 gpm, depending on the size of the unit. The manufacturer believes this unit to be the first to incorporate the use of a catalyst and scrubbers in a package-type unit.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Back-Up Rings

Back-up rings, spirally machined of Tetrafluoroethylene (Du Pont's Teflon) have been designed by The Garlock Packing Co. to prevent extrusion of O-rings. The Teflon rings have a high impact strength at temperatures from −100 F to 500 F and are non-corrosive, non-adhering, non-fraying, inert to most chemicals and self-lubricating, according to the company. They are made for all O-ring sizes to AN drawings 6227 and 6230. Further information is available from The Garlock Packing Co., Dept. 34, Palmyra, N. Y., or any of their branches.

Pneumatic Oiler and Filter

An oiler for lubricating pneumatic tools is now being marketed by the Air-Speed Tool Co., 1502 West Slauson Ave., Los Angeles 47, Cal. Trade-named the Air-Speed Williams Pneumatic Lubricator, it features light weight (12 ounces), Neoprene shock-absorber O-ring mountings, and a non-breakable, clear-vision window to show at a glance when the oil supply needs replenishing. Any good oil up to SAE 30 may be used, Air-Speed engineers say, and fittings are adaptable to all standard-size air lines. The device may also be used on a stationary machine line.

The device can be supplied without the filter element, otherwise being identical. The manufacturers state that tests indicate the device makes for marked increase in production, with no time-out for lubricator maintenance, plus longer tool life. Immediate deliveries are made.

Globe, Angle, and Check-List Valves

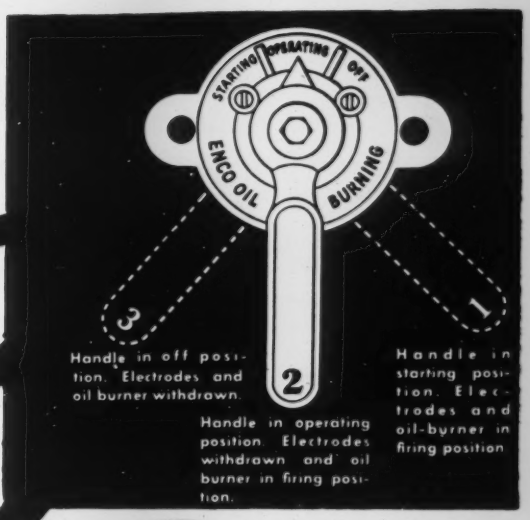
Another in a series of new developments, marking the 91st anniversary of The Lunkenheimer Co. of Cincinnati, Ohio, is its redesigned line of 600-lb Small Steel Globe, Angle, and Check-List Valves. Two new features, a "full-way" plug-type disc with increased seating width and a new chromium stainless steel seat which eliminates conventional seat rings, have been incorporated into these valves.

The introduction of the "full-way" plug-type disc into the line enables Lunkenheimer to discontinue the throttling-type seat and disc valve. Lunkenheimer's new disc, made of Type 420 chromium stainless steel, has a 500 Brinell hardness. Type 420 stainless steel, also used in the manufacture of its valve stems, has been a feature of the company's line for years.

The "lay-on" seat, Type 410 chromium stainless steel containing 13 per cent chromium, has a 350 Brinell hardness.

Elimination of the use of seat rings solves ring breakage and ring joint leakage, two of the primary causes of excessive valve maintenance costs and failures, the company declares.

Hand Control Valve for cylinders . . . wall mounting . . . oil burner ignition system.



1 Step
IGNITION SYSTEM
FOR PULVERIZED COAL, OIL, OR GAS

FAST
SAFE
POSITIVE

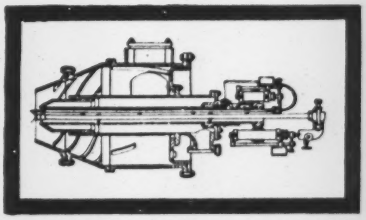
With an Enco Ignition System, operator can light off any burner by movement of a Hand Control Valve, located close to the pulverized-coal mill and fan controls, and within view of the instrument board. Automatically, a powerful ignition spark is established, and the light fuel turned on. Both are interlocked electrically — **the oil valve cannot be opened until the spark current is on and the atomizer is in firing position.** After the oil flame is established, a second movement of the control valve retracts the electrodes, leaving the atomizer in operation.

After ignition of the pulverized coal is established, a third movement of the control valve shuts off the oil and retracts the atomizer out of the hot zone, leaving the unit ready to repeat the operation as may be needed.

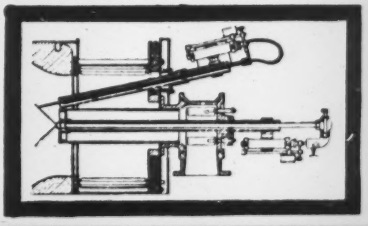
The Enco Ignition System has a wide range of application. Pulverized coal, blast furnace gas or any liquid fuel may be ignited by the unit, or the spark alone may be used to ignite natural or refinery gas. The ignition flame can be changed gradually from light to heavy fuel oil if continued operation under heavy load is required. The ignition flame also can be used as a substitute for principal fuel in emergencies.

Bulletin on request.

Atomizer and electrodes in the central tube.



Atomizer and electrodes in separate tubes.



THE ENGINEER COMPANY
75 West Street, New York 6, N. Y.

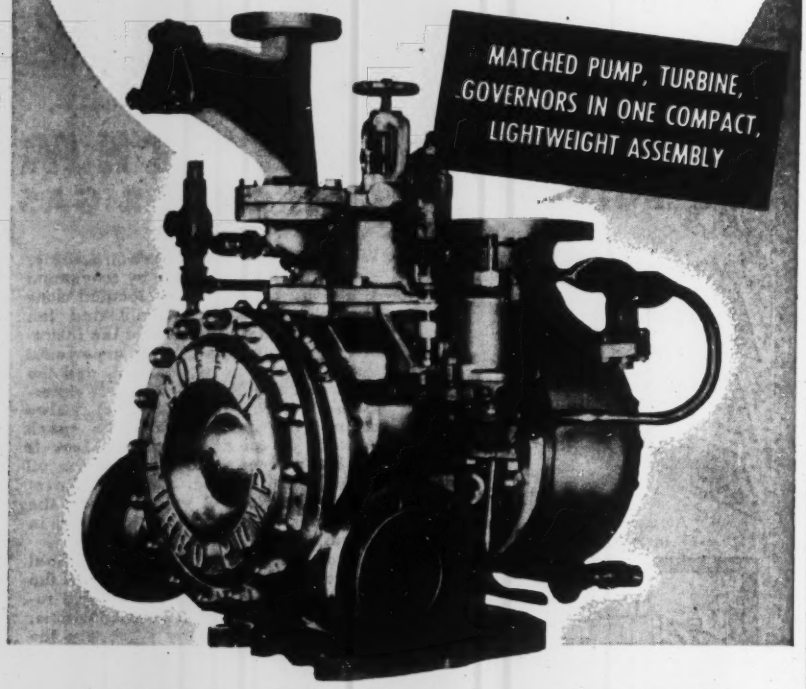
Enco OIL BURNING EQUIPMENT

SAVE STEAM, SPACE AND WEIGHT... INSTALL

COFFIN TURBO PUMPS

Designed and built expressly for boiler feed service, Coffin high pressure, single stage turbo pumps conserve steam on even the most difficult pumping assignments. All parts are standard and replacements are easily installed without fitting. New Handbook available now – for free copy, address Dept. ME.

– for high efficiency boiler feed service!



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The John H. Marvin Co.

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CABLE ADDRESS: COFCO

The J. S. COFFIN, Jr. Company
324 SOUTH DEAN ST., ENGLEWOOD, NEW JERSEY
REPRESENTATIVES IN CANADA, EUROPE AND THE FAR EAST

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Plug Gage Handle

A "Universal" handle for Reversible go and no-go plain and thread plug gages in cabinet sets has been developed by Size Control Co., Chicago, Ill. Each gage member is supplied with an aluminum bushing, which permits the user to make up multiple combinations of go and no-go sizes in the Universal handle. Eight handles in a set will accommodate a range of plugs from 0.010 to 0.750 in. in diameter. The handle is made of anodized aluminum. Plug members can be adjusted to required length to minimize breakage.

Further information appears in Catalog No. 53, obtainable from the Size Control Co., 2500 W. Washington Blvd., Chicago 12, Ill.

Redesigned Carbide Drill Blanks

Redesigned standard cemented carbide twist drill blanks which improve twist drill performance have been announced by Carboloy Dept. of General Electric Co., Detroit, Mich.

The reduced thickness dimensions of the redesigned blanks enable drill manufacturers to strengthen the point of each drill, providing more steel backing for the tip, Carboloy engineers say. The five new sizes, TD-1 through TD-5, already are available for immediate shipment from stock.

Blow Gun

A new blow gun, designed with throttle valve that meters air pressure exactly with finger-tip control, has been announced by the Aro Equipment Corp., Byran, Ohio. The operator can regulate the flow of air at any desired rate by pressing the throttle valve. This makes the gun adaptable to requirements for cleaning jobs in shops, foundries, paint shops, machine shops, woodworking, construction, production lines, inspection, shipping, and many other uses, the manufacturer states. The valve can also be set for fixed pressure.

The blow gun is shaped to fit the hand and is built with one-piece cast housing.

Austenitic Alternate Stainless Steel

An austenitic alternate for 18-8 stainless has been developed by Allegheny Ludlum Steel Corp., for which it claims good cold-working properties, good weldability, and good ductility. Produced with manganese, chromium, and less than one per cent nickel as principal alloying elements, chromium-manganese stainless strip is now being produced in substantial quantities, and is available in most other forms.

The development work was undertaken because of the restricted usage of nickel, in an effort to obtain an austenitic stainless steel with less than one per cent nickel. This steel is needed where straight chromium steels are unsatisfactory as substitutes for 18-8.

In applications where critical requirements include the mechanical properties of welds, ductility, non-magnetic qualities, and cold working to high strength, the chromium manganese steels should be considered, the company says.

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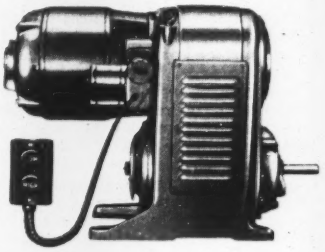
Plating Waste Treatment

The treatment of electroplating rinse waters in industrial plants through the use of ion exchangers has been considered in recent years for the elimination of complex water pollution problems. One of the most successful applications of this process has been toward the recovery of chromic acid from electroplating solutions, and the process has been extended to the treatment of mixed chromate rinse waters, the recovery of cyanide from cyanide plating rinse baths, etc.

Information on these newer applications is contained in Bulletin No. 3865, an 8-page preprint of a paper "Plating Waste Treatment" given by C. F. Paulson, Special Applications Engineer, The Permutit Co., New York 36, N. Y. Table, charts, cost and space comparison requirements, and other data supplement the material, which describes some of the forms in which industrially important metals can be economically recovered.

Remote Control Motor Operates Variable Speed Motor

A totally-enclosed auxiliary motor has been developed to provide a positive electrically-driven control for U. S. Varidrive motors by U. S. Electrical Motors Inc. Called the ERC remote-control motor, it is compactly attached to the Varidrive, replacing the control handle, and is operated by a push button. This auxiliary motor is $^1/_{15}$ hp, 1800 rpm, of the reversible capacitor type. It has a low-inertia rotor for quick stop.



A worm drive actuates the Varidrive's speed-control shaft as well as the adjustable limit switches. The connection box is an integral part of the unit. By use of the ERC unit, the Varidrive can be operated from a control station distant from the motor. It is described in a new Bulletin, No. 1797, obtainable from U. S. Electrical Motors Inc., Box 2058, Los Angeles 54, Cal.

Water Spray Sprinklers

Featuring a new deflector which departs from previous sprinkler practice by directing no water at the ceiling, Grinnell Spray Sprinklers introduce a higher standard of effectiveness in extinguishing fire and preventing its spread, the company claims.

Superior protection of the ceiling against high temperatures which would involve it in the fire has been demonstrated and resulted in approval by the Factory Mutual Research Laboratories and listing by the Underwriters Laboratories, Inc. Said to be especially effective against severe fires in fast-burning materials such as high-piled rubber tires,

How Can Pangborn Dust Control Save You Money?

Here's how these firms saved with Pangborn:

Nalco salvages $50 a day

National Aluminate Co., Chicago, Ill., **uses seven Pangborn Dust Collectors to trap valuable chemical dusts at the source . . . saves well over $50 a day. Nalco reports that reclamation savings "have already paid for the Pangborn Collectors."**

Hamilton cuts maintenance $100 a month

Hamilton Rubber Co., Trenton, N. J., **installed Pangborn Dust Control to improve employee morale and reduce plant housekeeping. Pangborn did this and *more*—savings in maintenance, housekeeping, and machine repairs give Hamilton a bonus of $100 a month!**

THE case histories above tell our story. Whether you want to increase profits by reclaiming valuable dust or cutting maintenance costs . . . whether you're interested in improving working conditions or community relations . . . whether your needs are big or small, Pangborn will solve your dust problem. For information on how Pangborn can save you money, mail the coupon below now!

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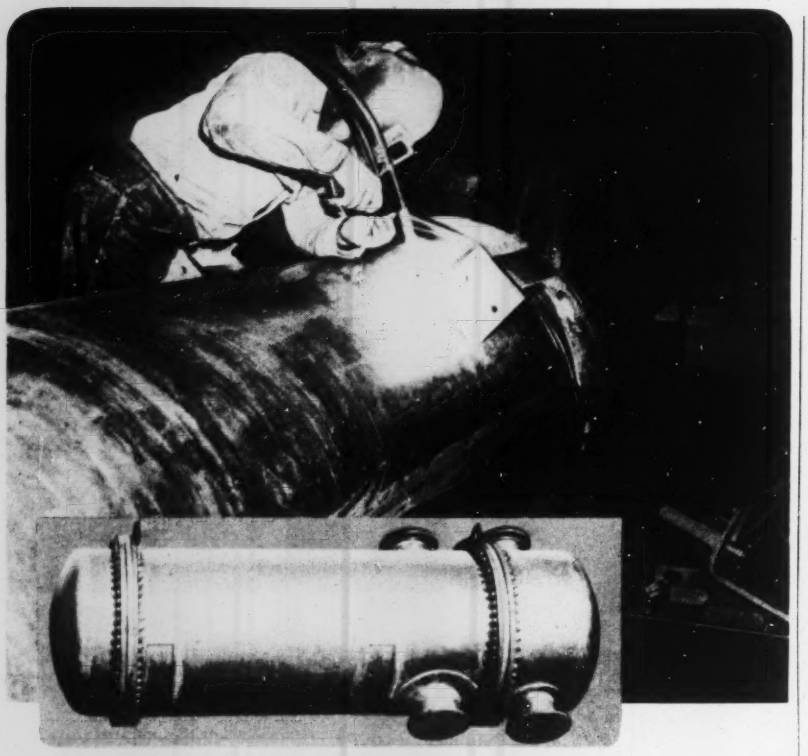

Here showing "Aircomatic" welding on Aluminum shell of a 54" o.d. x 10' fixed tube sheet Heat Exchanger. Inset shows the completed job of one of three such units on the order.

experienced craftsmanship

. . . yes, let DOWNINGTOWN's experience and research in the fabrication of various grades of Carbon Steel, Stainless Steels, Nickel-Clad, Stainless-Clad, Monel-Clad, Cupro-Nickel, Aluminum, etc. be of help to you. We are equipped with the most modern facilities to handle complete jobs, within our limitations, in the correct alloys and methods of fabrication required to assure maximum operating efficiency.

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STEEL AND ALLOY PLATE FABRICATION AND HEAT EXCHANGERS

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flammable liquids and materials with flash-fire characteristics, the new Spray Sprinklers employ a new method of attack to extinguish fire and limit its spread. Fast dissipation of heat is accomplished by rapid evaporation of the finer droplets in the new Spray. This helps prevent ceilings and other materials near the fire being raised to temperatures at which they would distill off flammable vapors or gases to feed the flames.

Whereas standard sprinkler deflectors put approximately half the water on the ceiling the new spray deflectors use the available water more efficiently, Grinnell reports. Advantages claimed for the Grinnell Spray Sprinkler are that it puts out more fire with less water, gives superior ceiling protection, improved spray distribution, and a wider margin of safety in protecting hazardous materials.

Data-Reduction Instrument

The Gerber Scientific Instrument Co. has announced the development of the Graph-Analogue, a new instrument in the Gerber Variable Scale family. The GraphAnalogue handles linear functions as well as arbitrary nonlinear functions directly, thus eliminating much of the time and drudgery normally spent in processing data, the manufacturer declares.

The Gerber GraphAnalogue multiplies graphs or curves directly. It divides a distance into any number of equal spaces, or into logarithmically proportional lengths, or into any arbitrary nonlinear proportion. Gerber estimates its usefulness greatest in data reduction where oscillogram recordings can be read directly in the final dimensions, irrespective of the shape of the calibration curve. The GraphAnalogue is about 14 in. long, 5 in. wide and $\frac{1}{2}$ in. thick. It is completely mechanical, and has a built-in dovetail slot to be used on boards or in gangs.

The instrument has 18 scales, including logarithmic, probability, trigonometric, power, linear, and reciprocal, and a Graph Paper Insert which allows the user to work with any arbitrary nonlinear function. The purpose of the Graph Paper Insert is to read, plot, and interpolate graphs, curves and scales involving nonlinearity. Typical applications are found in reading oscillogram or telemetering curves where a nonlinear calibration curve is necessary; plotting from curves; interpolating between families of curves where linear, or logarithmic interpolations are too inaccurate; reading one set of data directly converted to another set; plotting nomograms, etc. Accompanying each Graph-Analogue is an instruction manual.

Further information is available from the Gerber Scientific Instrument Co., 89 Spruce St., Hartford 1, Conn.

Stud Drivers

Heli-Coil Corp., Danbury, Conn., has announced the availability of its new two-page, two-color bulletin No. 653 on its line of Aero-Thread stud drivers.

Photographs illustrate these stud drivers and their components: collets, driver bodies, nose pieces, handles, etc. Tables provide specification data to aid users in the selection of hand or power models. Text describes the advantages of their use in driving or extracting all types of studs. Aero-Thread stud drivers are precision-built tools that have the ability to drive studs without marring threads or dulling points. Copies of Bulletin No. 653 are available from Heli-Coil Corp., 1363 Shelter Rock Lane, Danbury, Conn.

KEEP INFORMED

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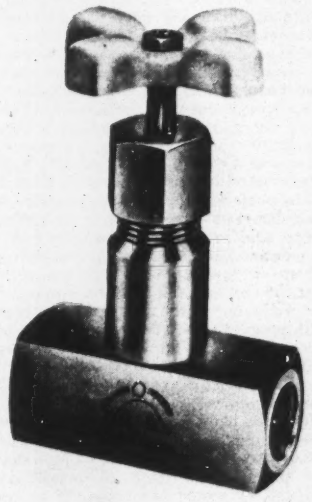
Needle Valve

An all-steel construction Needle Valve designed for working pressures up to 10,000 psi has been developed by the Jas. P. Marsh Corp. of Skokie, Ill. These valves are claimed by the manufacturer to be the answer to dependable, safe, and accurate control over a wide range of service requirements.



Valve bodies and valve stem guides are machined from heavy bar stock steel, and are joined into a sturdy one-piece construction by an exclusive Marsh process known as "Conoweld." The fusing of the valve stem guide and valve body into an integral unit, rather than the usual threaded connection, is said by Marsh engineers to provide a positive leakproof joint and eliminates the danger of the valve stem guide becoming loose while unscrewing the valve stem.

Deep-chambered threads are machined to extra long length. Valve stems of 416 stainless steel with fine-pitch threads have been carefully engineered to permit a close throttling and yet retain the strength necessary to withstand pressures of twice the normal working pressure. The packing used is of a special quality called "Marpak," tailor-made to fit the extra-deep packing space provided on all Marsh Needle Valves. Valve body, packing gland, and packing nut are electro-zinc-plated to prevent corrosion. The handle is a cross type of malleable iron finished in baked enamel.

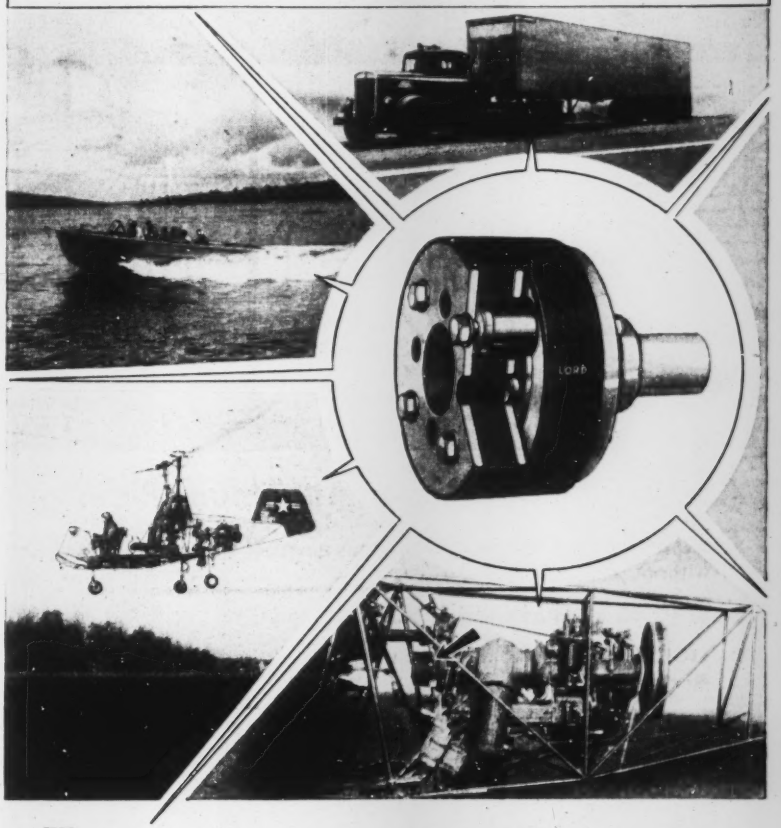
Automatic Drilling and De-burring Machine

A drilling and de-burring machine which has a double feed and operates automatically has been announced by Inter-Lakes Engineering Co., 4845 Bellevue, Detroit 7, Mich. The machine is designed principally for second operations on screw machine parts up to 1 in. in diameter and 2 in. long, drilling holes at any angle desired. It operates automatically, the only attention required being to keep the hopper filled, according to the manufacturer, and its production capacity is 3000 pieces per hour.

ON LAND, SEA AND AIR

LORD Flexible Couplings

TRANSMIT THE FULL POWER OF BOEING TURBINE ENGINES



HERE again you see at a glance Lord versatility in designing bonded-rubber components for a wide diversity of machines. The photo at top right shows the Boeing Gas Turbine-Driven Truck-Trailer for heavy cargo hauling. At the top left you see a United States Navy personnel boat driven by the Boeing Gas Turbine Engine. Directly beneath is the Kaman Helicopter powered by the Boeing Gas Turbine Engine; details are clear in the foreground. The Lord Bonded-Rubber Flexible Coupling designed for the job transmits the power in each machine.

Special requirements like these reach satisfactory and economical solutions at Lord, Headquarters for Vibration Control. We invite you to take advantage of more than a quarter century of design experience and craftsmanship.

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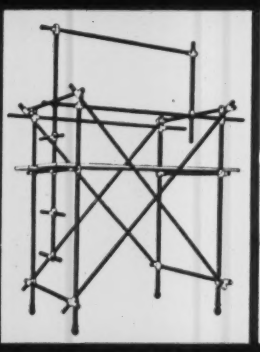
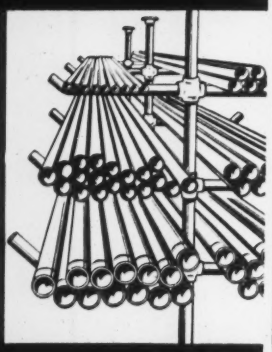
LORD BONDED RUBBER

Headquarters for VIBRATION CONTROL

Structural Uses for ALCOA ALUMINUM PIPE

Quickly, easily assembled with Hollaender Slip-On Fittings of Alcoa Aluminum. Other types of fittings also available.





RAILINGS SCAFFOLDS RACKS

Advantages of Alcoa Aluminum Pipe:

1. **RESISTS CORROSION**—Withstands most contaminated atmospheres without painting.
2. **STRONG**—Has excellent mechanical properties.
3. **LIGHT**—Schedule 40 aluminum weighs *one-third* as much as schedule 40 steel.
4. **ECONOMICAL**—Requires little or no maintenance.
5. **BRIGHT AND CLEAN**—Modern, good-looking appearance.

Most Alcoa distributors and jobbers stock structural pipe and fittings in standard sizes, but Alcoa can supply other sizes to your specifications. Consult your local Alcoa Sales Office or write: ALUMINUM COMPANY OF AMERICA, 903-G Alcoa Bldg., Pittsburgh 19, Pa.

Alcoa Aluminum

ALUMINUM COMPANY OF AMERICA

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Clad Metal Plant

A new Clad Metal plant which will produce gilding metal clad steel strip for bullet jackets for the United States Army is ready for full scale operation by Superior Steel Corp. The plant will increase Superior's clad metal capacity from 30,000 tons to approximately 80,000 tons per year.

Built and equipped jointly by Superior and the Ordnance Corps at a cost of $7,757,865 the plant will operate under new methods and processes which are expected to save the government between $100 and $150 a ton. The basic clad metal process, which Superior developed in 1939, has saved 80 per cent of copper and zinc in each bullet jacket.

Announcement that the new facilities are ready for full scale production was made jointly by Carl I. Collins, Superior president, and Colonel J. B. Goodell, military chief of the Pittsburgh Ordnance District.

The plant will operate under a unique contract between Superior and the Ordnance Corps, said to be one of the few of its type ever entered into by the Government with private industry. The contract provides that the Government shall have first call on the production of the new plant, but that the facilities may be used commercially when they are not required for Ordnance production. Superior will pay the Government rental on all Government-owned facilities used for commercial production.

The new plant was erected with galvanized steel roofing and aluminum siding covering 100,000 sq ft of floor space. Its production line progresses through an elongated "S" shape and is a model of modern plant layout. Although the plant was equipped mainly from government funds, the Superior Steel Corp. supplied the land, buildings, water mains, sewer lines, drive-ways, electric lines, overhead cranes and the heating plant.

Among the many pieces of heavy equipment installed for present clad metal production, some of the more ingenious machines designed for the new plant include a continuous fusion-welding machine, a grit blast machine, a channel forming machine, and a billet assembly table.

Gasket Stripping

A new gasketing material, claimed equally effective at the high temperature of hot-air ovens for chemicals and the low temperatures of arctic regions or high-altitude flying, has been developed by the Joclin Mfg. Co., 2964 Whitney Ave., Hamden, Conn. Called Fluorlastic gaskets, they combine the chemical resistance of Du Pont Teflon tetrafluoroethylene resin with the resilience and flexibility of silicone rubber. Their properties are unaffected by temperatures ranging from −90 C (−130 F) to 200 C (392 F), according to Du Pont.

The gaskets consist of long strips of foamed silicone rubber wrapped in sheets of Teflon. These are formed to permit edges of the sheeted Teflon to extend laterally beyond one side of the silicone core. The edges are then heat-sealed to form an impenetrable envelope around the resilient core material.

The resulting gasket, which looks like weather stripping, is intended for use in chemical, pharmaceutical, and aircraft industries. Because both Teflon and silicone rubber are unaffected by temperature over a wide range, it is expected that this gasketing material will find many applications by oven and autoclave manufacturers.

Conveyor Controls

Two devices for use on conveyors and chutes have been made available to general industry by the Johnson-March Corp., Philadelphia, Pa., to control related operations in the handling or processing of materials. These controls can activate signal lights, auxiliary conveyors, or other controls.

The model UB automatic conveyor control is designed for operation and installation under the belt. It is especially useful with belts conveying coarse, abrasive, or lump material, and is mounted beneath the belt on a spring-loaded shaft, which exerts light tension on the shaft arm and the master wheel rolling against the belt. A deflection of as little as $\frac{1}{16}$ in. on the belt actuates the limit switch arm.

Three adjustments are available for installation of this equipment. The shaft and brackets will fit standard-size conveyors from 16 to 48 in. wide. Shafts for wider conveyors can be supplied.

The Model 4A automatic conveyor control is installed over the conveyor belt. It opens and closes the switch control by means of a paddle arm. This type of control is recommended primarily for fine, light-weight materials which would not deflect the belt, or for use on chutes and pan and roller conveyors.

A paddle moved by any variation in material flow on the conveyor causes the limit switch to open and close. The paddle arm is flexible at the knuckle to prevent shocks against the switch arm, and the paddle on the paddle arm is made of $\frac{1}{2}$-in. soft rubber. While any movement will operate the switch, greater lifting of the paddle does not put any tension on the switch arm. This control comes complete with pipe and brackets to fit any size conveyor belt.

KEEP INFORMED

NEW EQUIPMENT
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Mild Steel Welding Electrode

A new, easy operating, mild steel E-6010 electrode, Fleetweld 51, has been put on the market by The Lincoln Electric Co. of Cleveland, Ohio. It is a shielded arc electrode designed for all position welding with direct current.

Lincoln states that the new Fleetweld 51 is well suited for welding of all types of joints in the overhead or vertical position and is especially well suited for "vertical up" welding. It produces flat-faced fillets when welded in a vertical position and reduces sagging or excessive convexity on welds made in any position, according to the manufacturer. This new electrode is available in 14-in. lengths and in diameter sizes of 1/8 in., 5/32 in., and 3/16 in.

Steam Trap

A new side inlet—side outlet steam trap with 1-in. or 1 1/4-in. threaded connections, No. 814, is being manufactured by the Armstrong Machine Works, Three Rivers, Mich. Body and cap are cast semi-steel; valve and seat, hardened chrome steel; and interior trim, stainless steel.

Capacities range up to 6800 lb/hr, depending on the pressure; pressure range is 0 to 250 psi. Height is 13 5/8 in.; diameter, 9 in.; weight, 45 lb. Additional data is available from the manufacturer.

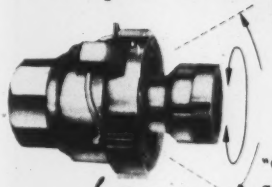
Extra-Low-Carbon Stainless Steel

Extra-low-carbon grades of stainless steel are explained in a booklet published by Armco Steel Corp. The grades are 18-8 ELC (Type 304 L) and 18-12 Mo ELC (Type 316 L).

Some of the subjects covered are: carbon and corrosion; conservation of scarce alloys with these steels; elimination of a carbide-dissolving anneal; high-polish surface; performance under the Huey accelerated corrosion test; and welding. The booklet is illustrated and includes tables on chemical analysis and typical mechanical properties. The booklet points out that the ELC grades should not be used for welded equipment exposed in service to temperatures above the sensitizing temperature of 800 F.

WHEREVER PIPING MUST MOVE

—a specialized BARCO flexible joint!



for angular motion—
—also swivel motion

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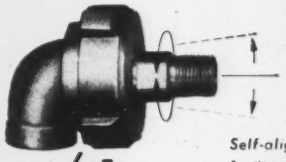
BALL JOINTS

"One joint does the work of two or more!"—because it moves in any direction. Standard the world over where low cost, leakproof movable joints are needed in piping handling steam, air, water, oil, gas, or chemicals. Many models available. Up to 40° side flexibility *plus* 360° swivel action. Also used to facilitate quick connection of piping, overcome misalignment. Pressures to 7,500 psi; temperatures to 1,000° F. 15 different sizes, ¼" to 12". *Ask for Catalog No. 215.*



for swivel motion—
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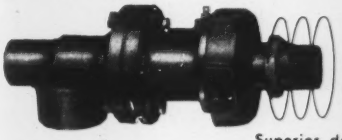
SWIVEL JOINTS

Self-aligning! Exclusive side flexibility (up to 10°) speeds up and facilitates installation; prevents binding. Widely used for making compact, low torque swivel connections to reciprocating or rotating parts on platen presses, tire molds, die casting machines, oil burners. Easy to position piping accurately—no sagging, flopping lines. Leakproof, safe—pressure or vacuum. Ratings as high as 600° F., 3,000 psi (hydraulic). Sizes, ⅜" to 2"; angle or straight. *Catalog No. 265.*



for continuous rotation—

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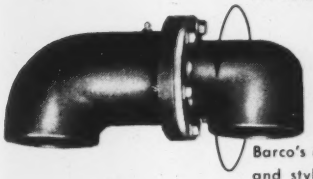
Superior design insures trouble-free performance, minimum roll drag, and up to 50% power savings. Inherent low torque is little affected by increasing pressure, speed, or temperature. Parts are easily accessible. Light running action minimizes wear, permits free-floating installations. No adjusting necessary—long, leakproof service. Ratings to 250 psi (steam); 450° F. Single flow or syphon styles. Sizes ½" to 2" and special to 5". Wide choice of models. *For detailed information, ask for Catalog No. 300.*



for swing motion—

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SWING JOINTS

Barco's new line of ball bearing Swing Joints is complete with sizes and styles to meet every requirement on loading racks, fueling assemblies, and chemical applications. "O" ring gives long life, leakproof seal. Full bearing surface, swiveling 360° in one plane (single swing) or in two planes (double swing), supports normal piping. Ball bearings can't fall out. Built in steel for pressures to as high as 1500 psi (hydraulic); temperatures, −40° to 225° F. 11 styles: straight, angle, double angle, counter balance. Sizes 2", 2½", 3", 4". *Catalog No. 400.*

BARCO *Manufacturing Co.*

521H Hough St., Barrington, Ill. (A Chicago Suburb)
In Canada: The Holden Co., Ltd.
The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Revolving Joints
FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

CHACE
BIMETAL
night watchman ...
IN NORTHERN ELECTRIC'S SHEET THERMOSTATS

Product of
Northern Electric Co.
Chicago, Illinois

THIS Northern Electric Sheet is "just the thing" to take along on that vacation, to the mountains, the lake or the seashore. You're assured of restful slumber, undisturbed by sharp dips in the temperature (so usual) while on vacation . . . and wake up rested, relaxed and ready to go. The reliability of the electric sheet temperature control and protective thermostats are largely dependent upon its Chace Thermostatic Bimetal element.

The automatic temperature control supplies the warmth you desire all through the night. When the circuit is closed, current passing through the thermostat is supplied to the sheet heating elements which maintain the temperature setting regardless of changing room temperatures. Like a night watchman, always alert but rarely called upon for action, the protective thermostats are an additional safety device. In the event of any kind of failure, the current flow is automatically controlled by these self adjusting thermostats.

Chace Thermostatic Bimetal is precision manufactured in 29 types, in strips, coils, random lengths and welded or brazed sub-assemblies. Before proceeding with the design of your new actuating device, consult our Application Engineers, recognized authorities on temperature responsive devices—or write today for our 32-page booklet "Successful Applications of Chace Thermostatic Bimetal," containing condensed engineering data.

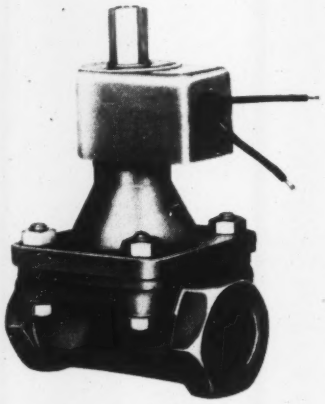
IT DRIVES WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1619 BEARD AVE., DETROIT 9, MICH.

KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

Pilot-Controlled Valve

The Automatic Switch Co., Orange, N. J., is announcing a new pilot-operated valve with Saunder's Patent-Type Valve Body (Special Bulletin 8336) for use in handling highly corrosive liquids and gases, and food products, particularly those containing solid particles. Its design is such that an absolutely tight shut-off is provided.



This valve has only two moving operating parts: the flexible diaphragm and the solenoid core. Pressure, air or liquid, is introduced directly from the pilot and impressed upon the diaphragm to close the valve. Upon release of this imposed pressure, the line pressure opens the valve. Valve bodies are cast iron, bronze, or stainless steel. A sanitary body as well as rubber or glass linings are available for handling food products.

Pipe sizes range from $1/2$ to 2 in. Standard voltages are 115–230 a-c, 50–60 cycles and 115 d-c. Other voltages at slightly higher cost. Maximum temperature is 180 F. Special enclosures available include: NEMA Type IV Watertight, and NEMA Type VII Class I Group D Explosion-Proof. A Class H High Temperature coil is available for 115 or 230 volts, 50–60 cycles only.

Maximum height from top of solenoid to bottom of body in the screwed and construction ranges from $6\,^{5}/_{16}$ in. for the $1/2$-in. size to $8\,^{5}/_{8}$-in. for the 2-in. size. For flanged end construction, heights for corresponding sizes are $7\,^{3}/_{8}$ in. and $10\,^{1}/_{16}$ in. respectively. The standard Asco pilot valve is satisfactory for pressures up to 125 psi. The Class H High-Temperature coil permits pressures up to 150 psi. Separate source pressure must always exceed line pressure, the excess varying with size and type of diaphragm. These valves can be changed from normally open to normally closed or vice versa by interchanging separate source connections to the pilot. No change of springs or other adjustments are necessary. Details on this Asco Valve, in Special Bulletin 8336, can be obtained by writing the company.

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LATEST CATALOGS

Portable Strain Indicator

A new Baldwin Model M Portable SR-4 Strain Indicator has been announced by Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa. The instrument is designed for operation with either batteries or a-c power pack, which is optional equipment. The new a-c power pack unit fits into the battery compartment and is mounted on a separate back cover of the instrument case. The Model M is functionally identical to the previous Model L. The only changes are a provision on the null indicator meter for checking a-c line voltage and the addition of a fuse beside the meter to protect the circuit when using the a-c power pack.

The principal advantage of a self-contained a-c power unit is convenience in using alternating current where it is available and the consequent elimination of the battery replacement problem. The instrument is also lighter in weight when the batteries are replaced. By operating on alternating current and keeping on hand a set of batteries, users are assured of dependable operation for laboratory and field conditions.

The indicator reads directly in microinches per inch up to 30,000 μin. per in. and can be used readily with an external Wheatstone bridge without modifying the internal circuit. It is also equipped with an oscilloscope connector jack to give access to a signal for measuring dynamic strains and for phase-balancing the circuit when long unbalanced cables are used.

Measuring accuracy is within plus or minus 2.5 μin. per in. for the "thousands" step. Slide-wire tolerance is plus or minus 5 μin. per in. and the gage factor adjustment is accurate to plus or minus $\frac{1}{4}$ per cent at any point. The instrument case is approximately $6 \times 9 \times 12$ in. The letters "MA" identify indicators with a-c power pack and "MB" identifies battery-powered units.

BUSINESS NOTES

Downingtown Iron Works Expands

Downingtown Iron Works, Inc., Downingtown, Pa., a division of The Pressed Steel Tank Co., of Milwaukee, Wis., is erecting and equipping a new building at Downingtown for the manufacture of pressure tanks for the storage of gases and liquids, ranging in sizes from 250 gal to 1750 gal water capacity. The building will also house their Heat Exchanger Div., thus providing additional space for the production of these units.

Diamond Power Specialty Opens New York Office

Diamond Power Specialty Corp. has announced the establishment of a New York Marine Sales Office at 165 Broadway, New York 6. The office is under the supervision of H. L. Walker, marine sales manager. The present New York Stationary Sales Office at 37 West 43rd St. will continue to handle sales other than marine under the supervision of T. M. James, New York district manager.

Forgings — closed die forgings — with their unmatched economic and mechanical advantages offer quick and complete solutions for Problem Parts problems confronting any member of a production team.

Consult a forging engineer about the closed die forging process for producing parts with the correct combination of mechanical properties required for your product.

Engineering, production and economic advantages obtainable with closed die forgings are presented in this Reference Book on Forgings. Write for a copy.

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Please send 60-page booklet entitled "Metal Quality — How Hot Working Improves Properties of Metal," 1949 Edition.

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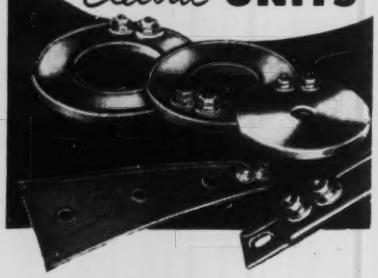
Electric UNITS



Only Chromalox gives you a full selection of electric heaters to meet every need. Over 15,000 types, sizes and ratings to choose from, most available from stock—for heating gases, liquids, platens, dies, molds, ovens, soft metals and countless other materials. Chromalox Heaters are easily and inexpensively installed, provide concentrated, controlled heat that is dependable, economical, safe, clean and efficient.

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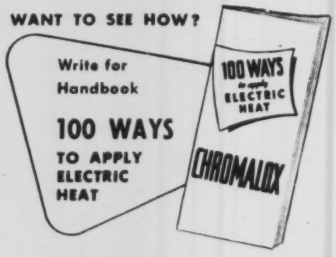

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Trane Announces New Location for Columbia Office

The Trane Co., manufacturer of heating, ventilating, and air conditioning equipment, announces that the new location of its Columbia, S. C. sales office is 2740 Devine St. Arthur M. Suggs is the sales engineer in charge of the office.

Orr & Sembower New York Office

Orr & Sembower, Inc., Reading, Pa., manufacturers of Powermaster packaged automatic boilers, has announced the opening of a New York office at 51 E. 42nd St. Jared Darlington III is district manager supervising the field sales activities in the metropolitan area, including Westchester County, Long Island, and northern New Jersey.

Complete engineering and servicing facilities are maintained by the New York district office to provide application engineering services and maintenance for Powermaster packaged automatic steam generators and hot water boilers.

Brown Boveri Awarded AEC Contract

The U. S. Atomic Energy Commission has awarded a $3,553,000 contract for electrical equipment for the new Portsmouth, Ohio, gaseous-diffusion plant to Brown Boveri Corp. The bid was $1,445,000 less than the next lowest bid.

The circuit breakers will be manufactured in Switzerland, where the principal Brown Boveri factory is located, but an estimated $2,000,000 of equipment will be subcontracted to American firms for manufacture in this country.

Brown Boveri has advised the AEC that if the international situation should become such as to threaten their Swiss factory, circuit breaker fabrication would be transferred to their Canadian plant.

General Electric's Welding Dept. Transferred to York, Pa.

The General Electric Co.'s Welding Dept., located in Fitchburg, Mass., since 1946, will be transferred to York, Pa., by the end of March, 1954, R. C. Freeman, general manager of the department, announced recently.

He explained that the planned transfer will enable the Welding Dept., and the company's Small Turbine and Supercharger Dept., which will remain in Fitchburg, to expand and thereby provide room for predicted increases in the business of both departments.

The Welding Dept. is scheduled to move into a newly vacated company plant at York, which will allow room for necessary manufacturing expansion. The plant formerly housed GE's Wire and Cable Div., which is being moved to two New England cities, Bridgeport, Conn., and Lowell, Mass.

Combustion Engineering-Superheater Changes Name

Combustion Engineering-Superheater, Inc., has announced that on April 15, 1953, the company changed its name to Combustion Engineering, Inc. There will be no changes of address for the New York office or the plants, the company stated.

Garlock Detroit Office Moves

The Detroit office of The Garlock Packing Co., manufacturer of mechanical packings, was moved in April to new and larger quarters at 2781 East Grand Blvd., Detroit. At the same time, the status of the Detroit office was changed from that of a subbranch reporting to Garlock's Cleveland office to that of a regular district office reporting directly to the main office in Palmyra, N. Y.

The Detroit district office under the direction of Edward M. Thomas, Jr., district manager, will serve the lower Michigan peninsula and the Indiana counties of Elkhart, La Grange, Marshall, St. Joseph, and Steuben. Substantial stocks of Garlock products will be carried at the Detroit warehouse in order to better serve Garlock customers in this area.

Parker Aircraft Acquires Aircraft Valve Line

Parker Aircraft Co., Los Angeles, subsidiary of The Parker Appliance Co. of Cleveland, Ohio, has announced its acquisition of Proof Industries' complete line of aircraft hydraulic directional control valves along with Proof's order backlog on these products amounting to approximately one million dollars.

According to S. B. Taylor, Parker president, the transaction included leasing of Proof's plant and facilities at 10,000 Exposition Blvd., Los Angeles, Cal., which will now operate as the Proof Division of the Parker Aircraft Co. Orders for the valves will continue to be received at this address. Henry Trich, designer of the Proof valves, will serve as manager of the new division.

Warren Steam Pump Appoints Chicago Representative

Warren Steam Pump Co., Inc., Warren, Mass., manufacturers of a complete line of centrifugal, reciprocating, and rotary pumps, has announced the appointment of Meters and Controls, Inc., 444 N. La Salle St., Chicago 10, Ill., as their sales representatives for the northern half of Illinois, lake counties of Indiana, and river counties of Iowa.

Meters and Controls, Inc., is an engineering organization of seventeen people and was established over thirty years ago. Mr. T. G. Robinson, president, is a graduate of Lewis Institute of Technology, and at one time was connected with Sargent & Lundy, Engineers, Chicago.

GIVE—so your RED CROSS can carry on!

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Westinghouse Breaks Ground for New Atomic Equipment Plant

Believed to be the first privately-financed atomic manufacturing plant, a multi-million-dollar factory, ground for which was broken on May 5, will house the newly-formed Atomic Equipment Dept. of the Westinghouse Atomic Power Div.

Charles H. Weaver, manager of the division, turned the first shovelful of earth on what used to be the Harmar Golf Course, located in Harmar Township approximately one mile northeast of the Allegheny Valley Interchange of the Pennsylvania Turnpike. On the 40-acre plot, construction has begun on a one-floor manufacturing plant of approximately 87,000 sq ft.

Expected to employ initially some 200 people and ultimately perhaps many times that number, the plant "will engineer, manufacture and sell products which have been developed for atomic power plants," Mr. Weaver said.

LATEST CATALOGS

Stainless Steel Bars

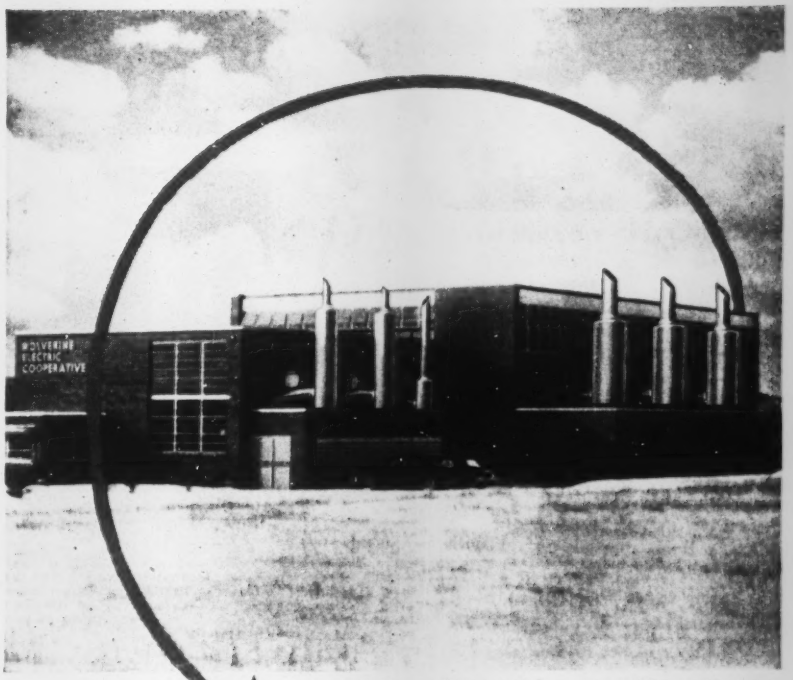
The first edition of a new technical book on stainless steel bars is available from Allegheny Ludlum Steel Corp., Pittsburgh 22, Pa. Included in the book is information to aid the user in the selection of the proper stainless steel material for the job at hand. There are reference tables on sizes and shapes available, weights, and corrosion resistance.

Included in the 28-page book is an eight-page section of fabrication and processing information for users of stainless bars. This section covers cutting, welding, forging, upsetting, machining, drilling, reaming, tapping, threading, turning, milling, annealing, and heat treating. The booklet is available on request to interested persons in the trade.

Picture Tubes

The eighth edition of its Picture Tube Data Chart has been announced by the Cathode-Ray Tube Div. of Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J. The chart, said by the company to be the most comprehensive of its kind, lists complete specifications for more than 150 picture tubes of all manufacturers, and is being made available to dealers and servicemen through Du Mont parts distributors. Over 100,000 copies of the first seven editions have already been distributed to the industry.

The eighth edition of the Du Mont Picture Tube Data Chart incorporates all newly manufactured 21-, 24-, and 27 inch tubes registered with the RTMA at the time of printing. Typical data listed for both magnetic focus and electrostatic focus types are: basings, bulb dimensions, deflection angle, radius of face curvature, envelope and contact, ion trap magnet, maximum design center values, application notes, and comparative focus current. Printed on heavy stock, the chart is suitable for wall hanging and is also folded to handy notebook size.



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Standard Snubber* designs are available, incorporating Air Cleaning, Spark Arresting, Water Separation, Waste Heat Recovery, and Surge Control Features.

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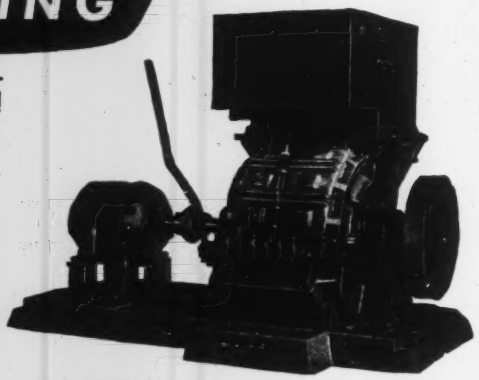
AMERICAN Laboratory Size Mills

With the same reduction action as Metal Turnings Crushers (or hammer action)—American Laboratory Size Mills offer an efficient means for reducing razor blades, pewter castings and fragile thin brittle steel to a reclaim product.



AMERICAN Metals Turnings Crushers

Bulky, hard-to-handle turnings are rapidly reduced as much as 80% with this efficient, economical crusher. And the yield of cutting oil is increased 30 to 50 gallons per ton—proof of how profitable the installation of an American Metal Turnings Crusher can be for those who handle 20 tons or more of metal turnings a month.

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If you're in a feverish sweat because of a tough temperature regulating problem, you can set your mind at ease by standardizing on Keckley. Keckley regulators offer you positive, accurate control of kettles, vats, water heaters, or wherever temperature control is needed. You get extreme sensitivity and wide selection of temperature ranges from −40° to 340°F. No decrease in maximum pressure of 250 psi as size increases. This valve incorporates Keckley's basic Type AA regulator, interchangeable with their pressure, temperature and combination control units for simplified maintenance. Give complete requirements including operating temperature range desired. Check with Keckley today!

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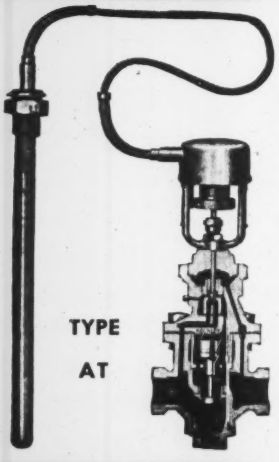

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KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

Multiple Nut-Runner

Ingersoll-Rand, 11 Broadway, New York 4, N. Y., has published a 4-page leaflet, Form 5099, on the applications of its multiple nut-running equipment. Uses in several general industrial fields are listed and illustrated. A brief table of model sizes and capacities is added.

Prepared-Atmosphere Generators

The Surface Combustion Corp., Toledo 1, Ohio, has issued a bulletin entitled "Prepared Gas Atmospheres for Heat Treating," containing information on prepared atmospheres and their properties and composition, and on the generators of these atmospheres, which are used in the heat-treating of metals. The effects of gas constituents are shown in a table, with their applications. Copies are available by requesting Bulletin SC 155 from the company.

Centrifugal Pumps

Bulletin 52C6059J, published by the Allis-Chalmers Mfg. Co., Milwaukee 1, Wis., is a handy guide to the selection of the company's line of centrifugal pumps. The pumps are applicable to different industries, for handling clear liquids, corrosive or abrasive liquids, or liquids containing large percentages of solids in suspension.

A table of recommended pumps for specified requirements, a head-capacity table, and illustrations of each style of pump are included. Available bulletins for each pump style are listed.

Hydraulics and Machine Tools

Vickers Inc. has purchased the copyright for the Henry Ford Trade School manual "Hydraulics as Applied to the Machine Tool Industry." The manual includes information about hydraulic pumps and valves and their maintenance and repair, and also the practical application of hydraulics to machines for the control of speeds and feeds.

As in the past, the manual will be available to the public, to industry, and to colleges, high schools and vocational schools throughout the United States and Canada at the same nominal charge of $2.00 per copy (including tax).

Further information is available from Product Service Dept., Publications Sec., Vickers Inc., 1500 Oakman Blvd., Detroit 32, Mich.

Alloy Spring Steels

"Alloy Spring Steels," 18 pages, with charts tables and photo-micrographs, compares the mechanical properties of three alloy steels, nickel-chromium-molybdenum (AISI 6150), and silico-manganese (AISI 9262) with plain carbon spring steel (AISI 1095). The paper, written by E. T. Bittner, research metallurgist, American Steel Foundries, concludes that, for exacting spring service, the factors of adequate hardenability, good surface, excellent mechanical properties, light decarburization, and cleanliness, together with reasonable cost, combine to make the nickel-chromium-molybdenum alloy steel the one to be employed. Reprints can be obtained from the International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.

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Insert Cutting Tools

"Report of Kennametal Performance" Nos. 425 and 426 have been published by Kennametal, Inc., Latrobe, Pa. No. 425 deals with the performance of Kennamatic tool inserts in grooving cast steel cable drums used on heavy earth-moving equipment. No. 426 covers the performance of Kennamatic tool inserts in turning railroad car axles. Both include operational data and illustrations.

The "Reports of Kennametal Performance" are available on request from the company.

Bronze Casting Alloys

The American Manganese Bronze Co. has published a 50-page edition of the "Reference Book on Bronze Casting Alloys," giving general information on composition, characteristics, and applications of many of the common or typical alloys.

Both alloy types and applications are indexed. A section on "Design as Related to Foundry Requirements" is included. An index of properties and characteristics, with recommended alloys for obtaining each, and a glossary of terms is contained in the book, available on request from the American Manganese Bronze Co., Holmesburg, Philadelphia, Pa.

Blue Print Reading

The fourth edition of "Simple Blue Print Reading With Special Reference to Welding and Welding Symbols" has been announced by The Lincoln Electric Co., publishers. The fourth edition contains new information and more drawings and photographs than previous editions. All symbols and other data have been revised to bring them up to the latest standards.

This is a new and enlarged edition of a book for welders and others engaged in the fabrication of machinery. It is intended as a guide to a clear understanding of blue prints and how to use them in mechanical fabrication and construction. Special attention is given to the use of welding symbols.

The book explains subjects such as perspective drawing, isometric drawing, sight projection, center plane lines, dimensions, scales, sections, explanatory views, development of weld symbols, and types of welds, and gives questions and answers on subjects. Its price is $1 in the USA, $1.50 elsewhere, and is available from The Lincoln Electric Co., Cleveland 17, Ohio.

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IF YOU WANT QUICK, ACCURATE READINGS *WITH SAFETY*

Don't overlook the advantages of FRAHM® RESONANT REED TACHOMETERS for hand or permanent mounting. *No contact with moving parts is required.* Just touch the instrument to the chassis, frame or housing of the machine or motor and read the rpm directly.

There are no moving parts, hence no lubrication or maintenance is required. Accurate to ½ of 1%, they will operate continuously for years without any appreciable change. Instruments with limited ranges available for as little as $27. Practically any desired range within 900 and 100,000 rpm can be supplied.

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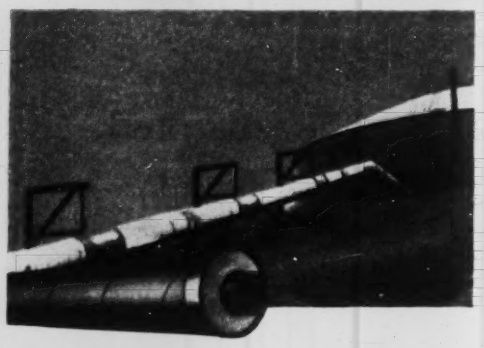

PROBLEM: City officials of Ishpeming, Michigan were concerned with providing the most economical method of connecting an elevated water storage tank at the top of a hill into the distribution system, with the line protected from freezing. Due to the ledge rock terrain, both an underground pipe line and rock tunnel were rejected as too costly and impractical.

SOLUTION: Working closely with Ric-wiL's engineering department, the consulting engineers devised an overhead Ric-wiL supply line, properly insulated to keep the line from freezing, which could be constructed much more cheaply than any of the alternate methods.

The 12" steel water line is coated on the inside with Ricwilite phenolic resin for corrosion-resistance and covered with 3" thick Fiberglas insulation, with a ¾" steam tracer provided for stand-by use, if required. The entire prefabricated system is housed inside 21" diameter RIC-WIL HEL-COR Conduit, amply protected from the elements.

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Contractor:
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Ric-wiL PREFABRICATED INSULATED PIPING — UNDERGROUND OR OVERHEAD

THE RIC-WIL COMPANY · CLEVELAND, O.

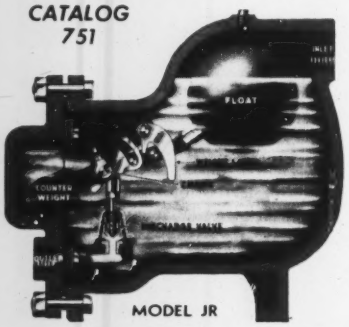
Solve Sludge Problem with Nicholson's *New* AIR TRAPS

With the introduction of an exclusive new oil-eliminating feature, Nicholson air traps now enable you to enjoy the advantages of the positive intermittent action of a float-operated air trap without the common problem of oil congealing on the mechanism and impeding or stopping its action. Other features of Nicholson air traps:

1) No air-wasting vent, such as is in all inverted bucket traps.
2) Positive water seal of valve.
3) Large orifice keeps valve clean, preventing blow-through.

Three types; pressures to 1500 lbs. For details send for . . . .

CATALOG 751



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Boiler Baffles

A new 4-page bulletin showing how streamlined baffles are applied to boilers of all types and sizes has been issued by The Engineer Co. Included in this bulletin are twenty-one drawings of boilers showing how these baffles are installed in each specific unit.

Advantages claimed for these baffle constructions are: increase in steam output, reduction of eddy currents, and elimination of dead gas-pockets and restrictive gas passages that increase draft loss without promoting heat-transfer. Copies will be sent upon request of The Engineer Co., 75 West St., New York 6, N. Y.

Mechanical Seals

Sealol Corp., 45 Willard Ave., Providence 5, R. I., has offered two bulletins on its mechanical seals. Bulletin 7 describes Sealol Pressure Seals, designed for high-pressure applications. Basic types of Sealol seals are illustrated and their features discussed. A table of dimensions and a section on installation and design are included.

Bulletin 9 covers Flexibox Mechanical Seals for oil refinery process pumps. The basic seal is shown, and the four additional features which can be included in components are illustrated and described. These bulletins are available on request from the company.

Industrial Castings

Meehanite castings for industry are described in a new eight-page folder published by the American Brake Shoe Co., Brake Shoe & Castings Div. This division produces five engineering grades of Meehanite and several other heat-resistant and corrosion-resistant grades. The booklet describes characteristics of the material, lists properties, and carries engineering information on hardenability, section strength, and comparative properties of other cast metals. Typical applications are pictured and a table of standard bar stock sizes is included. The folder may be obtained from American Brake Shoe Co., 230 Park Ave., New York 17, N. Y.

Wire Thread Inserts

Heli-Coil Corp., Danbury, Conn., has announced the availability of a two-page, two-color bulletin, No. 661, on wire thread inserts, entitled "Heli-Coil Thread Inserts—Modern Medicine for Tapped Thread Ills." The bulletin explains how wire thread inserts of stainless steel or phosphor bronze protect tapped threads in aluminum, magnesium, die-cast metals, plastics, iron, steel, brass, bronze, and wood.

Photographs show the range of standard sizes available. Also the bulletin explains wire thread insert use in design, production salvage and maintenance and lists the available thread classifications: National and Unified Coarse Thread Series, National and Unified Fine Thread Series, Automotive Spark Plug Series, Aviation Spark Plug Series, and Pipe Thread Series.

Six illustrated case histories present the design advantages of wire thread inserts in products such as automatic stapling machines, arc welders, paint brushes, induction furnaces, terminal boards, and calculating machines. Bulletin No. 661 is available from Heli-Coil Corp., 1321 Shelter Rock Lane, Danbury, Conn.

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NEW EQUIPMENT
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Steel Bolting

"Modern Steel Bolting for Piping and Pressure Vessels," by C. M. Vogrin, M. W. Kellogg Co., Frank S. G. Williams, Taylor Forge & Pipe Works, and John S. Worth, Bethlehem Steel Co., a reprint from ASME Paper No. 52-PET-7, has been made available by Taylor Forge & Pipe Works, P. O. Box 485, Chicago 90, Ill.

Each ASTM specification is commented on, and an extensive discussion of selection and assembly practices is included. Tables of chemical composition and physical properties of bolts, studs, and nuts are given, as well as a guide to flange material selection.

Copies are available on request from the company.

Quality Report Booklet

A new 12-page booklet, "The Quality Report and Its Advantages," published by the Hunter Spring Company of Lansdale, Pa., discusses the quality report, its interpretation and value to users of springs and other manufactured products. Written in a clear, brief style for engineers and purchasing agents as well as for inspectors, the handy 5-1/8 × 7-1/4-in. booklet is divided into eight sections covering such subjects as "Types of Inspection" and "How to Use a Quality Report."

A quality report is defined in the booklet as a frequency distribution of the critical characteristics of a product, prepared during final inspection by the manufacturer and delivered to the user with each shipment as graphic verification of conformance to specifications. The booklet describes, with a detailed and illustrated example, the preparation of a frequency distribution in variables inspection by either the user or manufacturer. A section called "Interpreting the Quality Report" gives fifteen typical frequency distributions and states for each what product condition it represents and what action is indicated. Single copies may be obtained by writing on company letterhead to Hunter Spring Co., Lansdale, Pa.

Aluminum Extrusions

A section on tolerances is featured in a 28-page booklet, entitled "Aluminum Extruded Products," that is being released to its manufacturing customers by Revere Copper and Brass, Inc. By extensive use of diagrams, Revere illustrates the standard tolerances of aluminum extruded shapes and presents them in five pages of tables for purchasing, engineering, and manufacturing departments.

Included with typical examples are the tolerances in detail for straightness, twist, corner and fillet radii, length, angularity, contour of curved surfaces, flatness, allowable deviation from square cut ends, and cross-sectional dimensions. Revere tolerances conform with the Standards of the Aluminum Assn., Extruded Products Div.

Additional information given includes a general introduction about aluminum extrusions, a description of the extrusion process itself, listings of Revere's extrusion alloys, some nomenclature and definitions, and five pages of material on the characteristics of its extruded products. The booklet may be had by writing to Revere Copper and Brass, Inc. at the company's executive offices, 230 Park Ave., New York 17, N. Y.

Multiply the
Effectiveness
of your remote
water gage reading
Reliance
EYE-HYE
can now
operate
auxiliary
alarms
Reliance EYE-HYE
RELIANCE
DANGER
NORMAL
LEVALARM
THE highly accurate EYE-HYE manometric gage has supplied reliable boiler water level indication on panel boards or other remote locations for more than 15 years. Now you can have auxiliary light signals or audible alarms anywhere in your plant, dependably operated by an electronic hook-up with the EYE-HYE.
Probes extending into the window unit and the calibrating tube complete an electrical circuit at the level of the indicating fluid. The signals or alarms coincide exactly with the reading in the always-accurate EYE-HYE. This new facility, added to the popular EYE-HYE, in no way interferes with the reliable operation of the remote gage.
With a two-light Levalarm Light Indicator, the red light warns of dangerously high or low water levels, the green light indicating a safe level. Vibratory electric horns or bells can be used in addition or instead of light signal.
Increase the safety of your water level control. Write for more information on the EYE-HYE with auxiliary alarms.
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NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Corrosion-Resistant Fastenings

The current issue of Harper "Bolt News," published for the users of corrosion-resistant fasteners by the H. M. Harper Co., features an article on Harper's new Aero Div. and its use of today's super-alloys. The new Harper division makes fastenings for jet engines and planes.

A step-by-step description of the cold-heading process used in manufacturing bolts and screws is also carried in this issue. Advantages and limitations of cold-heading are discussed. Other stories concern Harper fastenings in electric high-voltage switches and connectors, citrus-fruit squeezing machines, and weather-testing machines, and the first of a series on Harper distributors. Copies will be mailed free on request by writing Delphine S. Byrne, Editor, The H. M. Harper Co., 8251 Lehigh Ave., Morton Grove, Ill.

Centrifugal Blowers and Exhausters

U. S. Hoffman Machinery Corp. has published a new bulletin A-932, describing design and performance features of Hoffman multi-stage centrifugal blowers and exhausters for 1 to 9 psi pressures or vacuum from 2 to 12 in. mercury.

The bulletin lists 17 industrial applications, including several on which savings can be made by replacing high-cost compressed air formerly considered necessary, according to the company.

Also included are typical performance curves and check lists of data required for optimum blower or exhauster specification.

Copies are available from Air Appliance Div., U. S. Hoffman Machinery Corp., 105 Fourth Ave., New York 3, N. Y.

Flexible-Metal Hose

Titeflex helically-wound flexible metal hose and Uniflex helically-corrugated flexible metal hose are illustrated and described in Catalog No. 200, published by Titeflex, Inc., Newark, N. J. In addition to descriptions and specifications for flexible metal hose, fittings, and assemblies, the catalog contains information for ordering Titeflex flexible metal conduit and ferrules, Uniflex hose assemblies, ignition shielding and components for reciprocating engines, Titeflex bendable pipe, and Titeflex high- and low-frequency leads.

Featured in the Engineering Data section are charts showing frictional losses versus flow rates for various sizes of metal hose and conduit. These flow charts are believed by the company to be the first ever offered in a metal hose catalog and can be used as a standard for flexible metal hose of various types. The Engineering Data section also contains information on installation and maintenance of metal hose. A completely illustrated story is included showing how seamed metal hose is manufactured, from metal strip to completed assembly. Other photographs illustrate the construction of Titeflex convoluted metal tubing which is helically-wound from brass, bronze, nickel alloy steel, or monel strip, and of Uniflex seamless metal hose, which is helically corrugated from bronze, brass, stainless steel, and carbon steel tubing. Both types of hose are available with braids and fittings in a variety of corrosion-resisting metals for various hose applications.

Copies can be obtained from Titeflex, Inc., 500 Frelinghuysen Ave., Newark 5, N. J.

Lead and Axial-Pitch Checker

A four-page two-color 8 × 11-in. illustrated brochure, No. 48-53, covering the new Michigan Sine-Line Lead and Axial-Pitch Checker Model 1248, for checking large spur, helical and herringbone gears up to 48-in. in diameter is available from Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

In the brochure the use of the machine with a recorder, its gear capacities, and the use of either manual or power drive are discussed. Features of machine design and operation are covered and illustrated and specifications are given.

Photoelectric Recorder

A new two-color bulletin on photoelectric recorder applications has been announced as available from the General Electric Co., Schenectady 5, N. Y.

The fully illustrated 12-page publication, GEA-5536, describes applications of the recorder with seismology, psychology, textile, metals, fatigue, and research testing equipment, as an aid in the quick detection of pipeline corrosion, and in development and machinability testing, medical research, light-intensity study, and paper-machine-speed measuring.

A listing of the recorder's typical rating is included.

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DA PRESSURE CONTROLS PROVIDE THE SENSITIVITY YOUR APPLICATION REQUIRES

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NEW EQUIPMENT
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Clad Steel Sample Kit

To aid engineers and fabricators in the selection of desired finishes on clad steel plates, Lukens Steel Co., Coatesville, Pa., has prepared a new sample kit. Actual samples, polished to various finishes, are contained in pockets of a reference folder. The kit is available only to qualified buyers and users of clad steels.

Non-Metallic Disc Valves

A new extensively-illustrated circular describing the dimensions and functions of non-metallic disc valves has been prepared for distribution by The Lunkenheimer Co., of Cincinnati, Ohio.

The circular, printed in color, lists in detail the NMD valves, which can easily be renewed or converted to handle another type of service by the insertion of a specifically designed composition disc. The discs are made in three special-purpose types: for handling saturated steam; for cold water, air and gas; and for gasoline, oil, butane, and propane. Copies of this Circular No. 558 may be obtained by addressing requests to The Lunkenheimer Co., Box 360-U, Cincinnati 14, Ohio.

Power Products Directory

The Allis-Chalmers Mfg. Co., Milwaukee, Wis., has published a Directory of Products and Engineering Literature available from the company. Consisting of 40 pages, the Directory begins with a list of sales offices, both General Machinery Division and Tractor Division, in the United States and foreign countries.

An alphabetical list of Allis-Chalmers products is the principal part of the Directory. A listing of the titles and bulletin numbers of bulletins published by Allis-Chalmers follows, covering specific industries or items of equipment as well as general subjects. A two-page list of Allis-Chalmers trade marks and product names concludes the booklet.

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turning 25 lb. family bundles sunshine bright in Prosperity Individual Production Washers

• Turning the cylinder of this fully automatic 25 lb. Prosperity Individual Production Washer, at a speed of 36 rpm, is a Winsmith worm gear type speed reducer. It is depended on to speed each family bundle successfully through a complete washing and rinsing cycle . . . *without delay*.

Direct-driven by a ½ hp motor, and spinning the cylinder via a v-belt, this Winsmith Model 3½B, horizontal, single reduction unit was selected by The Prosperity Company, Inc. *"for its compactness, ruggedness and easy serviceability."*

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To serve *all* your speed reduction requirements within the 1/100 to 85 hp range, Winsmith is the *only* name you need to remember. For details, request Catalog 148.

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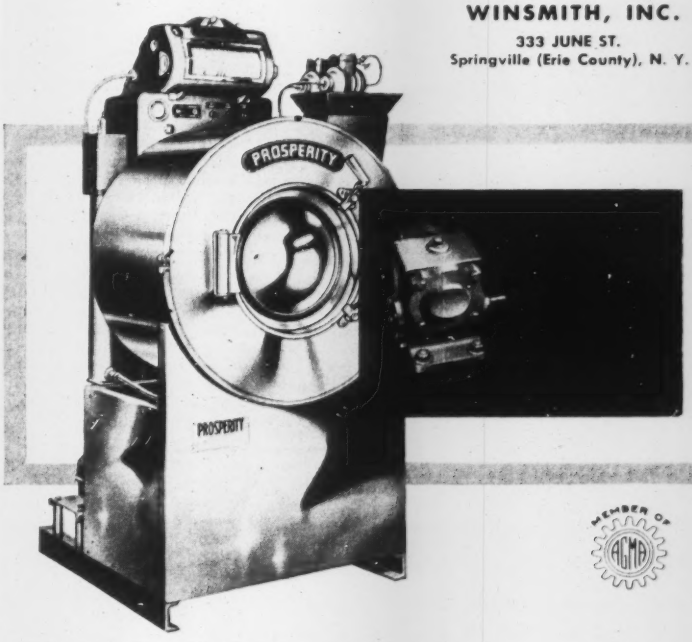

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Compressed-Air Filter

Instrument-quality air for all compressed air applications is now available from ordinary plant air, the Hankison Corp. declares. The Hankison Model B-30-D Condensifilter is described in an illustrated bulletin covering construction features, including the disposable filter cartridge, technical data, and dimensions. Applications and recommended usage are discussed. The bulletin is available from Hankison Corp., Biltmore Bldg., Pittsburgh, Pa.

Diesel Engines

A new bulletin entitled "New Developments in Oil Diesel, Dual Fuel Diesel and High Compression Spark Ignition Engines," by Volney M. Holmes, assistant manager, Engine Div., is being offered by Worthington Corp.

The bulletin, known as S-500-B55, describes and illustrates features of internal-combustion engines. It includes a heat-balance chart illustrating waste heat recoverable from exhaust gases and jacket cooling water. Accompanying the bulletin are fuel-cost charts for determining the most economical type of engine selection, and reprints describing industrial and municipal installations utilizing heat-recovery systems.

Included with Bulletin S-500-B55 are: Bulletin S-500-B54, with fuel-cost charts mentioned above; RP-492, Hyperion Sewage Disposal Plant (Los Angeles); and RP-481, "Diesels Make Potash in Utah." For additional information, requests should be directed to Engine Division, Worthington Corp., Buffalo 5, N. Y.

Blast Cleaning Hose Machines

Pangborn Corp., Hagerstown, Md., has issued Bulletin No. 100A, describing the blast cleaning hose machines which are produced for hand-operated cleaning jobs.

The 28-page bulletin begins by saying that, in spite of spectacular advances in automatic equipment and airless blast cleaning, there are many jobs which can only be accomplished by the use of hand-operated nozzle blast cleaning equipment. The direct pressure and suction methods of applying the abrasive are described as well as the applications of both wet and soft abrasives. Tables show the relationship between orifice area and circumference in nozzle sizes and air flow with required horsepower to develop air jets of varying diameters.

Selection of the proper type of Pangborn blast cleaning hose machine is discussed in the book. A table graphically shows how to match the nozzle size to the size of the abrasive being used. Various blast cleaning accessories are pictured and described. Specifications are given for the various types of Pangborn abrasives available along with recommendations for their use. Bulletin 100A can be obtained on request.

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under which all may serve

Specify THOMAS ALL METAL FLEXIBLE COUPLINGS for Power Transmission to avoid Costly Shut-Downs

DISTINCTIVE ADVANTAGES	
FACTS	EXPLANATION
NO MAINTENANCE	Requires No Attention. Visual Inspection While Operating.
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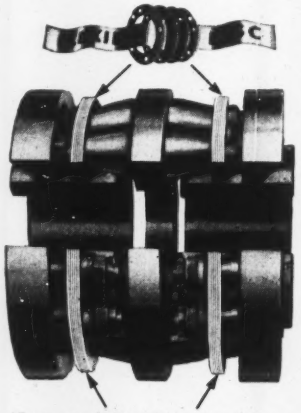
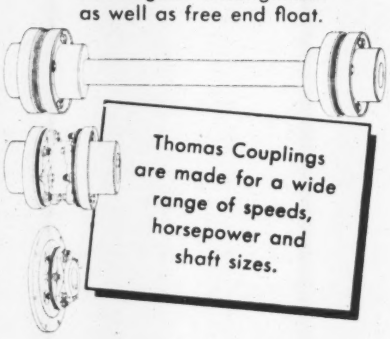


Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.



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THE THOMAS PRINCIPLE GUARANTEES PERFECT BALANCE UNDER ALL CONDITIONS OF MISALIGNMENT

NO MAINTENANCE PROBLEMS

ALL PARTS ARE SOLIDLY BOLTED TOGETHER

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WARREN, PENNSYLVANIA, U.S.A.

A vital message to the head of the family

Two ways you can protect your family against CANCER

. . . a check
. . . a check-up

Cancer strikes in one of every two families. Each year more than 60,000 American children under the age of eighteen lose a parent to cancer.

Yet many cancers can be cured, if discovered in time.

Every man should have a complete physical examination once a year. Women over thirty-five should have a complete physical examination twice a year.

Because of scientific advances, patients are being cured today who could not have been saved even five years ago.

The American Cancer Society asks your help in the fight against cancer. Your check today will help pay for costly research. Will help keep physicians informed of latest developments in detection and treatment. Will help pay for the training of doctors to specialize in cancer.

How soon we find cancer's cause and cure depends on how soon and how much help comes from people like you.

Invest your money today for your family's security tomorrow.

"Cancer" c/o Postmaster, (Your town)

Please send me free literature about cancer.
Enclosed is my contribution of $_____ to the cancer crusade.

Name_____

Address_____

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Cancer strikes One in Five
STRIKE BACK . . .
Give to Conquer Cancer

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Grinding Mills

Hardinge Co., Inc., York, Pa., has issued a 6-page circular, Bulletin AH-440, describing the complete line of Hardinge grinding mills and their application.

The circular contains cut-away views, installation photos, and description of Hardinge conical mills, rod mills, cylindrical mills, tube mills, batch mills, tricone mills, and "Thermomills." A list of materials successfully ground in Hardinge Mills and a description of Hardinge grinding accessories are also included.

Rust Preventives

The Rust-Oleum Corp. has released its 1953 General Catalog, 16 pages, describing its rust-preventive coatings.

The new catalog, featuring 73 color chips of Rust-Oleum products, includes instructions for surface preparation and application of Rust-Oleum primers, short-oil-type and long-oil-type coatings, machinery and implement finishes, chemical- and heat-resistant types of coatings, sealers, thinning oils, and floor and masonry coatings.

Two pages are devoted to questions and answers concerning surface preparation and applications of Rust-Oleum products. A free copy of the 1953 Rust-Oleum General Catalog will be sent on request for Form No. 252, the Rust-Oleum Corp., 2799 Oakton St., Evanston, Ill.

Core Dryer

The use of dielectric heat to overcome many disadvantages of conventional core baking methods in foundries is described by Carl Loper of Allis-Chalmers electronics section in an article, "Curing Intricate Cores With Dielectric Heat," now available in reprint form.

The article, which appeared in the First Quarter, 1953, issue of the Allis-Chalmers Electrical Review, tells of the development of the dual heat core dryer, and discusses the preparation and curing of cores and core assembly and casting. The back page of the eight-page reprint describes the company's redesigned foundromatic core dryer and lists its specifications.

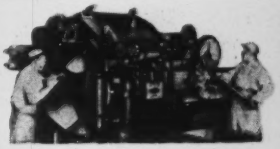
Copies of "Curing Intricate Cores With Dielectric Heat," 15R7973, are available upon request from Allis-Chalmers Mfg. Co., 949 S. 70th St., Milwaukee, Wis.

Gear-Motors

The function, design, and application of gear-motors are described in a new publication available from the General Electric Co., Schenectady 5, N. Y.

Designated as GEA-1437H, the 16-page, two-color information guide describes the standard types of GE Tri-Clad gear-motors with ratings from 1/6 to 200 hp. Cut-away photographs show the relative position of the parts which are distinctive to the design of each motor.

Adaptability to low-speed jobs and adjustable-speed drives are explained along with a description of gear-motor maintenance. The electrical types and characteristics as well as special mechanical features of gear-motors also are given. A table, listing more than 200 gear-motor applications, explains how to select the proper motor depending on use, load classification, and length of daily operation.



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Shown here are a few of the more than a thousand of American Sanitary plumbing goods made largely of Revere brass plumbers' tube. This tube is made by special techniques developed by the Revere Mills to assure easy fabrication into plumbers' items.

Almost every home in this great country of ours has plumbing. Most people never give a second thought to traps and bends and elbows, sink strainers, flanges and so on. But both Revere and American Sanitary Manufacturing Co., Abingdon, Illinois, think a lot about them. American Sanitary makes over a thousand such items for plumbing, and buys a great deal of Revere brass plumbers' tube, also hexagonal O.D., round I.D. heavy wall leaded brass tube for easy machining into fittings. The point about this long association between Revere and American Sanitary is that Revere uses special mill techniques to produce brass plumbers' tube. These techniques make it possible for American Sanitary to produce the bends, often at 180°, without cracking, without marring the finish. Thus nickel or chromium plating can be carried out successfully, and beautiful parts produced, the parts that householders admire, and which add to the value of both new and older houses. Thus, behind even the most taken-for-granted articles there is usually a lot of special skill and know-how. . . . If you would like to benefit from the capabilities of the Revere Mills, and of the Revere Technical Advisory Service, get in touch with the nearest Revere Sales Office. See your telephone directory, or write direct.

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KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Force Feed Lubricators

Manzel Model 25 Force Feed Lubricators are described in Catalog 25G, published by the Manzel Bros. Co., 315 Babcock St., Buffalo 10, N. Y. The Model 25 is a general-purpose lubricator, adaptable to a variety of engines, pumps, and compressors, and can be synchronized by rotary or lever drive in many arrangements and reductions, or can be operated independently by electric or air motor.

Featured advantages given by the manufacturer are: totally enclosed working parts; sight feed; wide range of feed; large filling cup; removal valve cages; stainless steel valve seats; individual pumping units for lubricating each point; precision ground plungers; large reservoir capacity; hardened steel ratchet wheels and pawls for quiet operation; leak-proof gauge glass fittings; hand attachment; and drain plug for cleaning. A cutaway drawing illustrates step by step the action of the Model 25, and sections on applications, styles and capacities, and dimensions and specifications complete the catalog, which is available on request.

Sintered Metal Parts

The United States Graphite Co., Div. of The Wickes Corp., Saginaw, Mich., has announced publication of an illustrated catalog containing full information about Gramix, the company's registered name for its sintered metal parts.

Gramix bearings, gears, and other parts are produced in a wide variety of ferrous and non-ferrous grades from metal powders, compacted under pressures up to 70,000 psi and sintered in high-temperature furnaces. They can be formed in relatively complicated shapes to tolerances as close as .0003 in. with little or no machining, according to the company, thus virtually eliminating scrap loss and metal waste; further metal savings are achieved because Gramix parts have a porous structure that requires less metal and makes it possible to oil-impregnate the parts during manufacture for self-lubrication.

The catalog describes the methods of manufacturing Gramix parts and lists the principle advantages they offer. A section is devoted to the special design factors that must be considered when designing for and ordering Gramix parts and explains the techniques in use for machining Gramix when such an operation is necessary. The chemical composition and physical properties of the ferrous and non-ferrous grades of Gramix are outlined in a comprehensive chart. An illustrated section shows 130 typical Gramix applications such as pump rotors and liners, bearings of all shapes and sizes, gears, gear blanks, cams, pawls, and ratchets. Laboratory operations at The United States Graphite Co. are described at length in interesting pictorial form. The catalog concludes with a Gramix Survey Sheet to help manufacturers plan their Gramix requirements. A list of other products of The United States Graphite Co. is appended. Copies of the Gramix catalog can be obtained without cost or obligation by writing to the company in Saginaw, Mich.

For Consulting Engineers
Turn to Page 130

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PUMP BOOST EVACUATE | AIR GAS LIQUIDS

Can Often BEST BE MET

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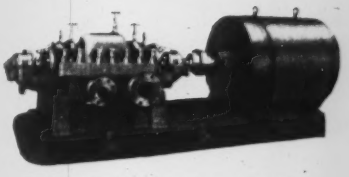
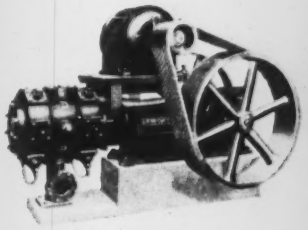
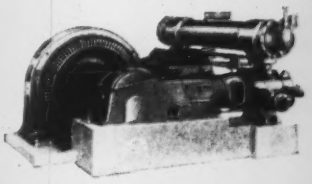


PENNSYLVANIA 2½-inch 6-Stage Class OHB THRUSTFRE Pump for Boiler Feeding. Bulletin 242-G



PENNSYLVANIA Horizontal, Single-Stage Heavy-Duty Compressor for General Use. Bulletin 201-G



PENNSYLVANIA Horizontal, Two-Stage Duplex Compressor for Larger Plants and for Soot Blowing. Bulletin 203-G

YOUR Copy of Catalog 546 briefly describes All PENNSYLVANIA Products

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PENNSYLVANIA Pump & Compressor Co.
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OILFREAIR® THRUSTFRE®
OILFREGAS® AIRCHEK®

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NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Surface Roughness

The Micrometrical Mfg. Co., Ann Arbor, Mich., has published Bulletin I-21, entitled "How to Specify Surface Roughness—and Why," available on request.

The booklet explains the meaning of surface roughness as applied to machined and finished surfaces, practical advantages of roughness specification, how to establish roughness specifications for parts in production and for parts of new design, how to specify microinch roughness on working drawings, and shop measurement of surface roughness.

Hydraulic Equipment for Mobile Machines

A new catalog covering its complete line of oil hydraulic equipment for mobile applications has been published by Vickers Inc. and is available in quantity to meet volume inquiries. Catalog M-5101 provides specification and engineering information on Vickers hydraulic vane-type pumps and motors, valves, power steering pumps and steering boosters, and other oil hydraulic units specifically designed for equipment in the automotive, materials handling, construction machinery, agricultural, and mining industries.

Inquiries should be addressed to M. J. Taup, Mgr., Mobile Products Sales, Vickers Inc., 1500 Oakman Blvd., Detroit 32, Mich.

Arc-Welding Accessories

Arc-welding accessories are described in a 12-page booklet available from the Westinghouse Electric Corp. This line of products varies from electrode holders and ground clamps to protective clothing and headgear.

All accessories are illustrated and in every case specification data are supplied. Where several models of the same accessory are shown, the special application characteristics of each are discussed. For a copy of the booklet, B-5451, write Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.

Threaded Inserts

The Groov-Pin Corp., 1125 Hendricks Causeway, Ridgefield, N. J., has offered a bulletin on its Tap-Lok Inserts, self-tapping, self-locking threaded inserts for use in plastics, wood, and soft metals. A new Engineering Standard Sheet, IN-30, recently printed, is also available on these inserts.

Reduction of failures of molded inserts, reduction of scrap losses, and elimination of service returns due to connector failures through floating inserts and pull-outs are among the advantages claimed for Tap-Lok Inserts. Ease of installation is emphasized by the manufacturer. The bulletin contains a table of installation torque requirements and tensile failure loads; the Engineering Standard includes a comprehensive table of dimensions. Copies are available from the company.

Industrial Soldering Irons

Soldering irons and soldering iron tips for industrial applications are described in a new bulletin announced as available from the General Electric Co., Schenectady 5, N. Y.

Designated as GEA-4519, the eight-page, two-color publication uses photographs, diagrams, and tables to describe soldering-iron construction, application, ratings, and prices. Also included is a full-page chart which describes the purpose of flux and which flux is best suited to the base material or applied finish.

Flexible Hose Vibration Absorbers

A new two-color bulletin on Flexon Vibra-Sorbers has been released by Flexonics Corp., formerly Chicago Metal Hose Corp. Complete up-to-date specifications, installation instructions, and supporting data are given.

Vibra-Sorbers are used to isolate vibration from connecting suction and discharge lines to refrigeration and air-conditioning machinery, pumps, and turbines. They are supplied with copper tube ends, straight or bent, in inner diameters to fit standard OD copper tube sizes in the rigid piping. Illustrated in the bulletin are some typical Vibra-Sorber applications.

The new literature, Bulletin V/S, can be obtained from Flexonics Corp., 1305 S. Third Ave., Maywood, Ill.

PRE-FABRICATED PIPING—ready for ▶ TROUBLE-FREE PERFORMANCE ◀

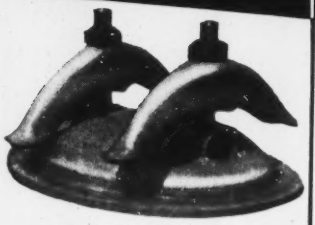
At Western Piping Supply every pre-fabricated piping assembly undergoes specialized shop testing before shipment.

Testing laboratories include a wide range of facilities, from hydrostatic pressure testing equipment through X-ray and gamma ray apparatus.

That's why WPS customers are always assured trouble-free piping performance in the field.

WESTERN PIPING SUPPLY DIVISION
THE LUMMUS COMPANY
504 WEST 145TH STREET, EAST CHICAGO, INDIANA
Representatives in Major Cities
FABRICATORS OF CARBON AND ALLOY PIPING

LENAPE MANWAYS and FITTINGS



11 x 15" N Fitting.

A wide variety of access openings.

Lenape elliptical access openings (straight rings or flued and curved saddles) and fittings, of the pressure loaded or "self-energized" type are produced in sizes ranging from 4" x 6" to 18" x 24".

Typical Lenape Fittings

- 11 x 15" Type L 150 PSI in steel, Everdur, and 304 Stainless.
- 11 x 15" Type N 450 PSI for general application.
- 11 x 15" Type S 250 PSI with external split recessed clamp plate for paper machine dryers
- 12 x 16" Type N 450 PSI for general application.
- 12 x 16" Type HP 800 PSI for heavy duty.
- 14 x 18" 300 PSI Hinged for beverage tanks.
- 18 x 24" 200 PSI for large clean-outs.

Full details are found on pages 35-42 of Lenape Catalog 9-49

LENAPE HYDRAULIC PRESSING & FORGING CO.
DEPT. 112 WEST CHESTER, PA.
RED MAN PRODUCTS

KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Air Grinders

The features of Ingersoll-Rand's air grinders are explained in Form 5096-A, available on request from the company at 11 Broadway, New York 4, N. Y. The Ingersoll-Rand overspeed safety coupling is discussed in detail, with cutaway views. Specifications, including recommended wheel diameters and hose sizes, are included.

Locknuts

Thin locknuts, one-third lower in height, which meet or exceed in many instances minimum Army-Navy tensile requirements for regular-height locknuts, are described by Standard Pressed Steel Co. in a 26-page catalog.

Sizes, fits, part numbers, dimensions, tensile values, materials, packing quantities, and weights are listed in the catalog for all Flexlocs in both thin and regular design and for aircraft and commercial use.

Flexlocs are made of various materials that can be used in temperatures from sub-zero to 750 F. In one section of the book, tests are described and illustrated that show that the locking section not only performs its locking function but also accounts for 20 to 30 per cent of the total tensile strength of the nut.

Also included in the catalog are data on Flexloc external and internal wrenching nuts and clinch-type locknuts. A copy of the Flexloc catalog can be obtained from Standard Pressed Steel Co., Box 558, Jenkintown, Pa.

Stress Rupture Values

A new data card has been published by the Tubular Products Div. of The Babcock & Wilcox Co. The card presents stress rupture data on a number of B&W Croloy tubing steels and other materials designed for high-temperature service. Copies of the card, known as TDC-153, are available upon request to the company's offices at Beaver Falls.

Valves

What is said to be one of the most complete and comprehensive valve catalogs ever published is being distributed by The Lunkenheimer Co. of Cincinnati, Ohio. The 506-page catalog, featuring a special 24-page Valve Selector Guide and over 100 pages of reference data, describes the complete Lunkenheimer line of steel, iron, and bronze valves, and lubricating devices, boiler mountings, cocks, and other products, including the new "Non-Slip" Handwheel.

The illustrated and thumb-indexed Valve Selector Guide, which groups valves according to the pressure classifications, enables engineers to find specifications, reference data, and code requirements for any Lunkenheimer valve in a matter of seconds. The volume is being distributed personally by Lunkenheimer sales representatives and distributors. Copies of the catalog may be reserved by writing to The Lunkenheimer Co., P.O. Box 360, Annex Station, Cincinnati 14, Ohio.

Power Wrenches

Bulletin 211D-1952 describes the power wrench manufactured by The Cushman Chuck Co. The bulletin illustrates the Cushman Power Wrench and accessory equipment. List prices are given along with dimensional data, wiring diagrams, and complete torque information for opening and closing large chucks.

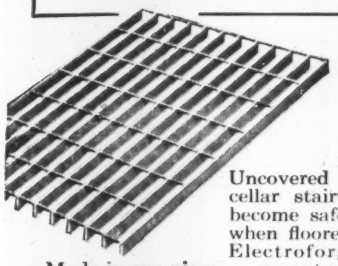
Cast Aluminum for Tools and Dies

An $8\frac{1}{2} \times 11$-in. brochure on Reynolds Aluminum Cast Plate and Bar has been published by Reynolds Metals Co., Louisville 1, Ky. It describes the product now being made available for use in tools, dies, jigs, and fixtures.

Large-size cast aluminum plates and bars were first developed for the aircraft industry where they proved their superiority in hydropress form blocks, hydro-stretch forming dies, press brake dies, master tooling fixtures, and setup and layout tables, as well as in machining and welding fixtures, Reynolds says. Since then they have been tried and adopted by other industries where low production or experimental work is involved.

The brochure explains the advantages of the aluminum cast plate and bar for tools, dies, jigs, and fixtures, lists sizes available, and includes specifications and properties. A free copy will be sent on request from Box PR, Reynolds Metals Co., 2500 South Third St. Louisville 1, Ky.

Make those **OPEN SPACES**
SAFE and USABLE
with this unique, one-piece
OPEN STEEL FLOORING

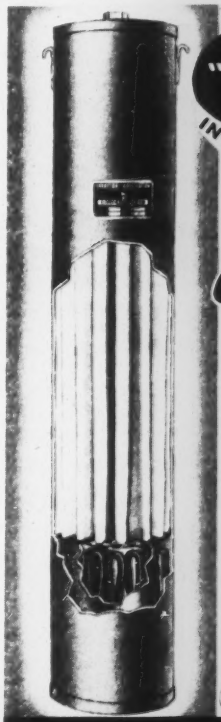


SILENT!
STRONG!
SECURE!

Uncovered pits, light wells, cellar stairways, etc. quickly become safe and usable areas when floored with Blaw-Knox Electroforged Steel Grating. Made in one piece . . . no nuts or bolts to rattle or lose. Provides safe footing even when wet or greasy and lasts indefinitely. Admits maximum light and air. Furnished in any shape, cut to fit. Just send dimensional sketch of area to be covered and we will forward price by return mail.

BLAW-KNOX COMPANY, *Grating Department*
BLAW-KNOX EQUIPMENT DIVISION
2105 Farmers Bank Building, Pittsburgh 22, Pa.

ELECTROFORGED® STEEL
BLAW-KNOX GRATING



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"INSTRUMENT-QUALITY" AIR
IN COMPRESSED AIR OPERATIONS

HANKISON
MODEL A-100-D
Condensifilter

Featuring the New—Economical
DISPOSABLE FILTER CARTRIDGE

- ***CONDENSER***
- ***MECHANICAL FILTER***
- ***AUTOMATIC TRAP***

Combined in a single unit!

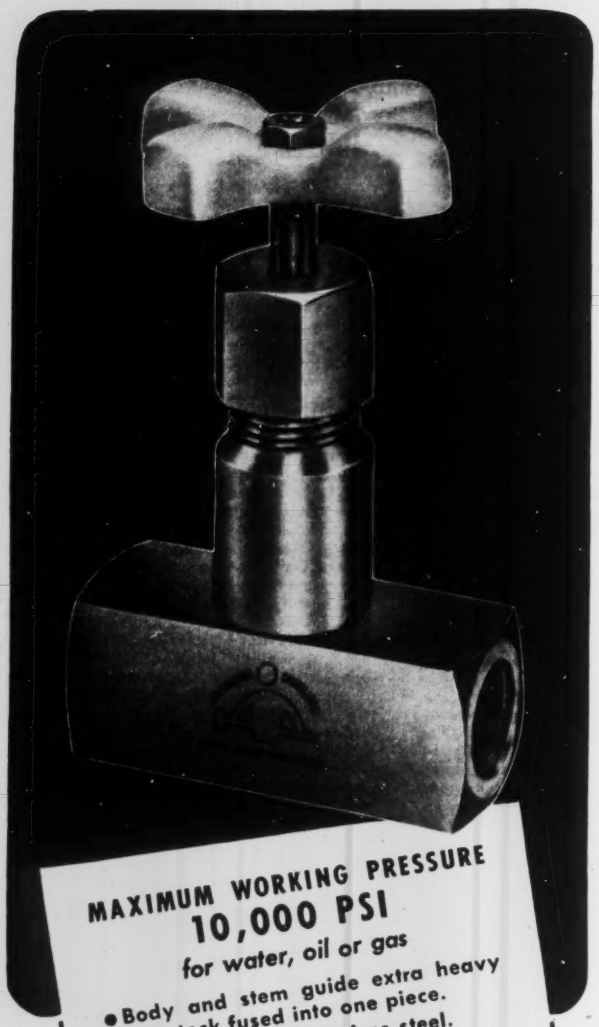
RATE OF CAPACITY:
100 scfm at 100 psig

MULTIPLE UNITS:
Installed in parallel
increase capacity

Consult us on your specific problems

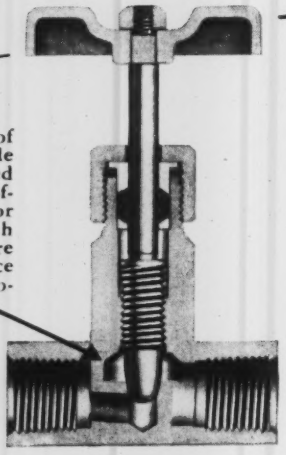
WRITE . . .
for illustrated bulletin DB-130

HANKISON CORPORATION
353 Biltmore Bldg., 951 Banksville Rd., Pittsburgh 16, Pa.



MAXIMUM WORKING PRESSURE
10,000 PSI
for water, oil or gas

- Body and stem guide extra heavy bar stock fused into one piece.
- Valve stem 416 stainless steel.
- Packing special one-piece "Marpak" moulded ring.
- Bodies marked in accordance with MSS regulations.



ONE PIECE

The stem guides of conventional needle valves are screwed into bodies—this often causes leakage or blow-outs. Marsh Needle Valves are fused into one-piece by exclusive "Conoweld" process.

Introducing-

The Ultimate in Needle Valves

Here is one of the crowning achievements of Marsh research, design, and manufacturing skill. It is the first needle throttling and shutoff valve to combine *all* of the qualities called for today in this highly critical and ever broadening field.

It is a valve that has strength and safety to spare . . . rated for pressures up to 10,000 psi—equally efficient in the lower ranges. A product of Marsh instrument-making and valve manufacturing experience, it combines instrument-like precision with the ruggedness that distinguishes all Marsh valve specialties.

The illustrations tell the story of new thinking; new standards. Body and stem-guide are machined from extra-heavy carbon steel bar stock. Still greater strength and rigidity are achieved by fusing the stem-guide into the body. The complete fusion of guide and body is accomplished by the exclusive Marsh "Conoweld" process.

There are two big advantages to this one-piece construction: (1) It eliminates the danger of unscrewing the valve from the body when opening—a frequent cause of leakage, even dangerous blow-outs (2) It permits perfect line-up of threads and seat. As a result, Marsh valves are easier to operate even at high pressures.

The precision-machined stem is 416 stainless steel. Stem threads are fine pitch for extra strength and fine, controlled regulation. Notable advancements are special "Marpak" one-piece, non-binding longer-lasting packing; deep thread chambers, keeping inlet and outlet piping away from ports and contributing excellent flow characteristics. Entire packing nut and packing gland are electro-zinc plated, preventing corrosion and giving the valve a handsome, plated exterior. The rugged malleable handle is finished in heavy baked enamel.

The new needle valve line includes globe and angle patterns with double female connections in sizes ⅛", ¼", ⅜", ½", ¾" and 1". Also globe and angle valves with male inlet and female outlet in sizes ¼" and ½". *Complete stock carried at our Skokie, Illinois factory and also at our branch plant in Houston, Texas.*

Write today for catalog giving complete details.

MARSH INSTRUMENT CO. *Sales affiliate of Jas. P. Marsh Corporation*
Dept. 29, Skokie, Ill.
Houston Branch Plant: 1121 Rothwell St., Sect. 15, Houston, Texas

MARSH

"THE STANDARD OF ACCURACY"

an easy way to cut your production costs

OILITE does it—

with FINISHED MACHINE PARTS

machining this segment costs ..... $.70

OILITE segments cost ..... $.08

machining this saddle slide costs $1.30

OILITE slides cost ..... $.07

Other Advantages Include:

- No investment in machine tools
- No costly tooling programs
- Releases skilled manpower to other jobs
- No material supply problems

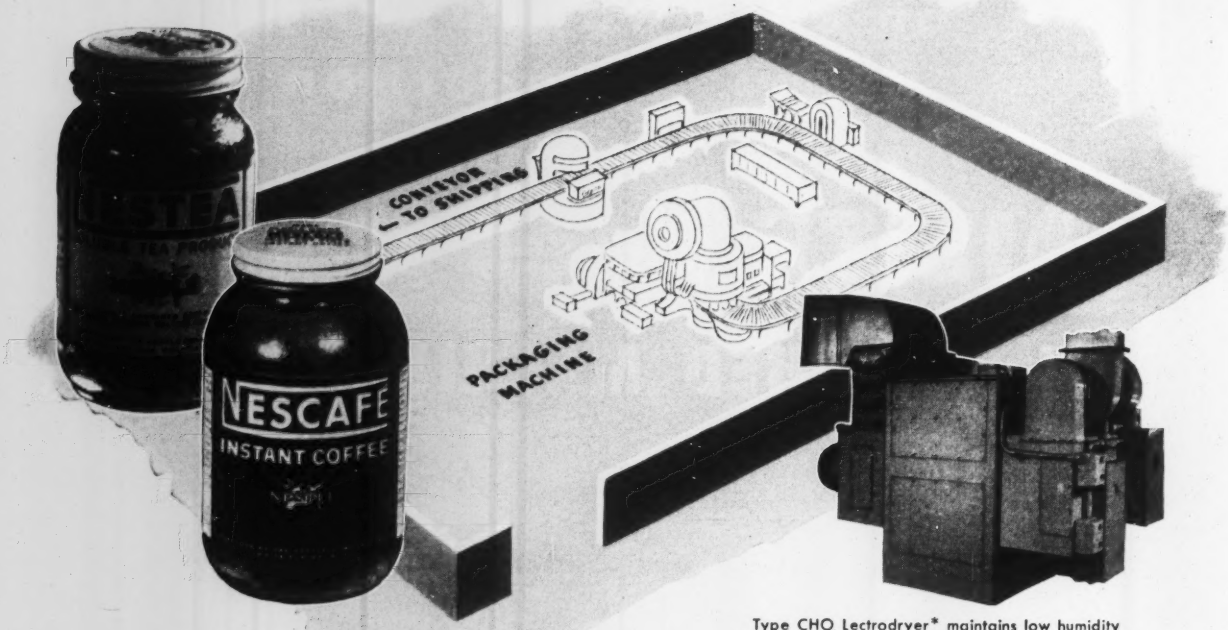
AMPLEX MANUFACTURING COMPANY

Subsidiary of Chrysler Corporation

DETROIT 31, MICHIGAN

FIELD ENGINEERS AND DEPOTS THROUGHOUT UNITED STATES AND CANADA

Oilite Products Include: Bearings, Finished Machine Parts, Cored and Solid Bars, Permanent Filters and Special Units.



Type CHO Lectrodryer* maintains low humidity in The Nestlé Company packaging room.

"Our packaging machines don't gum up in summer any more . . ."

Summer air can contain above 500% more moisture than winter air. No wonder machines gum up! No wonder production stalls! A CHO Lectrodryer has cured these ills at the Nescafé* plant of The Nestlé Company, Inc., Sunbury, Ohio. Summer or winter, the air in packaging rooms is DRY. Production flows smoothly.

Lectrodryers are drying some production areas to as low as 10% relative humidity, regardless of weather conditions. Others are DRYing air, gases and organic liquids to dewpoints as low as −110°F.

If moisture is causing you hardship or production lags, you'll benefit by the experience of our engineers. Talk over your problem with us, or write Pittsburgh Lectrodryer Corporation, 335 32nd Street, Pittsburgh 30, Pennsylvania.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVi.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege

LECTRODRYERS DRY
WITH ACTIVATED ALUMINAS

LECTRODRYER

* REGISTERED TRADEMARK U. S. PAT. OFF.

To get better prints... faster

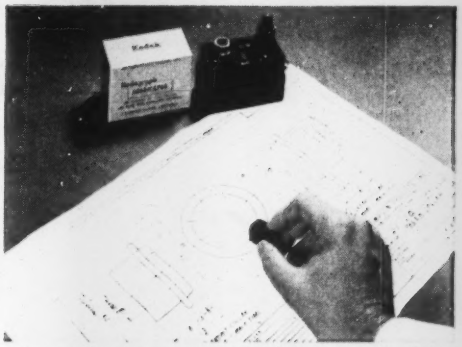
Tapco Plant, Thompson Products, Inc. uses Kodagraph Autopositive intermediates in print production.

The Tapco Plant knows full well that illegible shop prints pave the way for costly reading errors; knows, too, that Kodagraph Autopositive intermediates are low-cost insurance against such a possibility.

It therefore reproduces its more critical and complex jet and valve drawings on Kodagraph Autopositive Paper Translucent and thus obtains—quickly and easily—sparkling "masters" for print-making which have dense photographic black lines on an evenly translucent, premium-quality paper base; *which* will produce highly legible whiteprints time after time at *stepped-up* machine speeds.

Extremely fine-detailed drawings are reproduced on Kodagraph Autopositive Film, which captures the faintest detail . . . keeps close lines from "filling in". . . and produces top-quality photographic intermediates which have extremely fast print-back speeds.

No negative step . . . no darkroom handling. Kodagraph Autopositive Paper and Film are handled in exactly the same manner . . . produce positive photographic intermediates *directly*. First, they are exposed in one of the Tapco Plant's direct-process machines—or in a photocopy unit. Then, they receive standard photographic processing. A fast, convenient room-light operation all the way. And no new equipment needed.



Autopositive intermediates save creative drafting time. Tapco Plant makes necessary changes in its basic designs without costly redrafting by (1) making Autopositive prints of the original drawing; (2) removing the unwanted detail from the Autopositive reproduction with eradicator fluid. Then, the draftsman has only to add the new detail . . . and a print-making master is ready. *One* which will produce highly legible prints without confusing "ghost" images in the eradicated area.

Autopositive reclaims "unprintables." Many old drawings that have lost line density or are soiled or torn are transformed into print-making masters by reproducing them on Autopositive Paper or Film. Stains and crease marks are dropped out . . . weak detail is made more legible—saving hours of redrafting. Autopositive Paper is also used to duplicate a variety of office records, non-translucent vendor prints, etc.

Kodagraph Autopositive Materials

"THE BIG NEW PLUS" in engineering drawing reproduction

MAIL COUPON FOR FREE BOOKLET

EASTMAN KODAK COMPANY 16

Industrial Photographic Division, Rochester 4, N.Y.

Gentlemen: Please send me a copy of your illustrated booklet giving the facts on Kodagraph Reproduction Materials.

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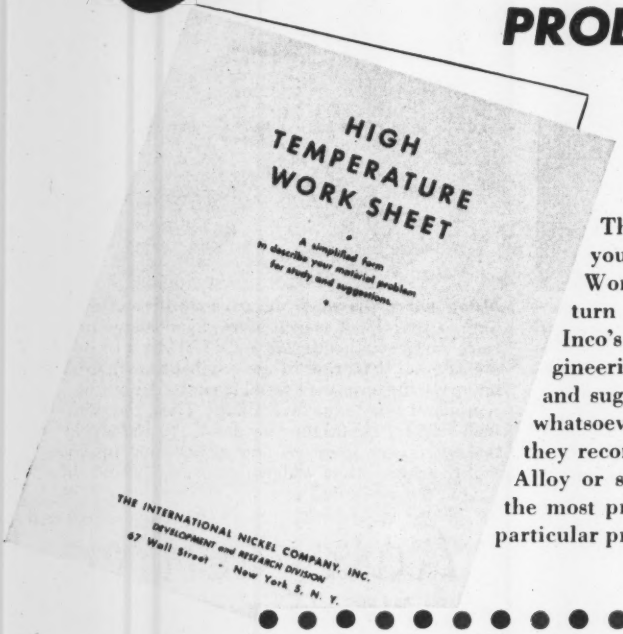
Kodak
TRADE-MARK

the first step

TO SOLVE YOUR HIGH-TEMPERATURE PROBLEM


HIGH TEMPERATURE WORK SHEET
A simplified form to describe your material problem for study and suggestions.
THE INTERNATIONAL NICKEL COMPANY, INC.
DEVELOPMENT and RESEARCH DIVISION
67 Wall Street - New York 5, N. Y.

This coupon will bring you our High Temperature Work Sheet so that you can turn your troubles over to Inco's High Temperature Engineering Service for analysis and suggestions. No obligation whatsoever, of course, whether they recommend an Inco Nickel Alloy or some other material as the most practical answer to your particular problem.

INCO

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

Please send me the High Temperature Work Sheet so that I may outline my problem to you.

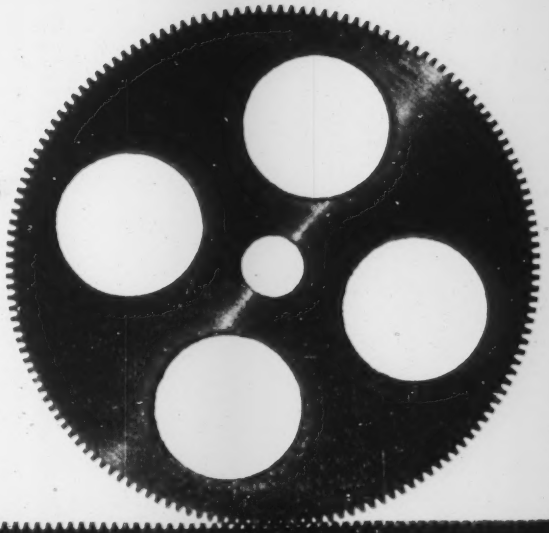
Name_____

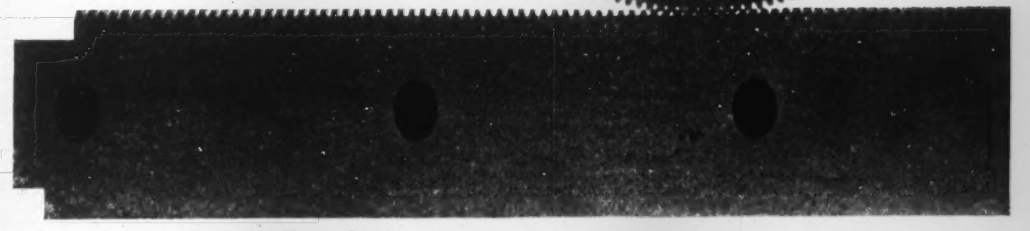
Company_____

Address_____

City_____ State_____

Here's *Why* you can check precision gears *more conclusively* with Kodak Conju-Gage Gear Checkers

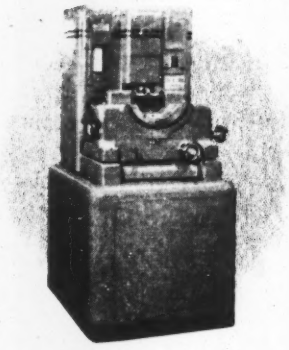




Why the composite check

Errors in gears seldom occur individually—they're usually combinations of as many as six types of errors. The practical way to test gears for these errors is to test them in action through the composite check recommended in the new American Standard (AGMA 236.02; ASA B6.11-1951).

This check measures gear errors as variations in center distance when the gear is rotated in contact with a master of known accuracy. Since this variation is the sum of errors in both gear and master, the degree of precision measurable depends on the precision of the master.



The Kodak Conju-Gage Gear Checker automatically records the composite effects of runout, base pitch error, tooth thickness variations, profile error, lead error, and lateral runout. Illustrated is the Kodak Conju-Gage Gear Checker, Model 4U, for gears up to 4⅛" pitch diameter. Larger and smaller models are also available.

Why the Conju-Gage Gear Checker

Kodak Conju-Gage Gear Checkers use a master of exceptional accuracy, the Kodak Conju-Gage Worm Section. These Worm Sections are generated by the continuous action of a thread grinder under control of a precision lead screw—circular pitch error and tooth thickness variations cannot be introduced by defects in an intermittent indexing mechanism. This means a more accurate gaging element, less chance that error in the master may coincide with a tolerable error in the gear to result in a needless rejection. Less chance, too, that an error in the master may subtract from an intolerable error in the gear, passing a gear that will fail in use.

By passing each right gear, rejecting each wrong gear, the Kodak Conju-Gage Gear Checker helps you reduce costs while maintaining highest precision. For the full story of this and other economies achieved by Conju-Gage instrumentation, send for the booklet, "Kodak Conju-Gage Gear Testing Principle." Write to:

Special Products Sales Division
EASTMAN KODAK COMPANY, Rochester 4, N.Y.

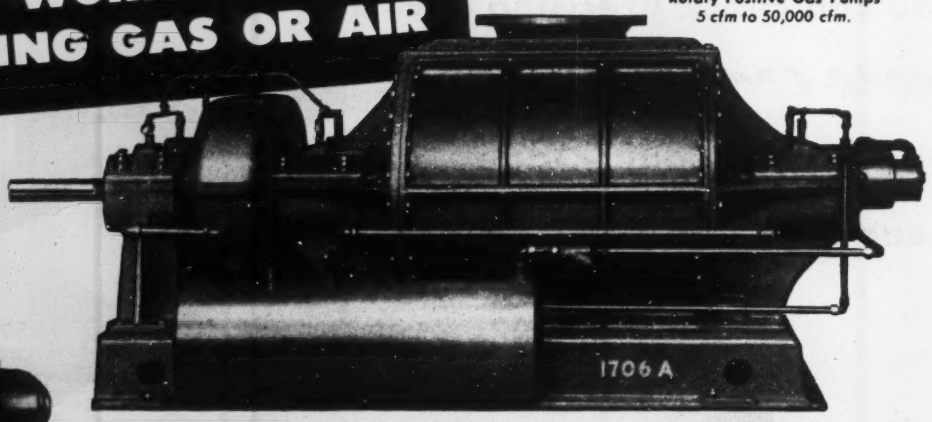
CONJU-GAGE INSTRUMENTATION

. . . a new way to check gear precision in action

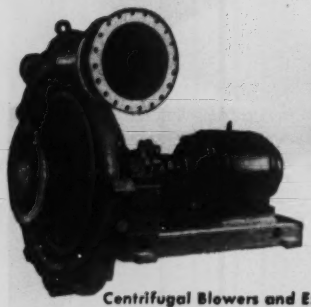
To inspect all kinds of complex parts on a bright screen, Kodak also makes two highly versatile contour projectors.

Kodak

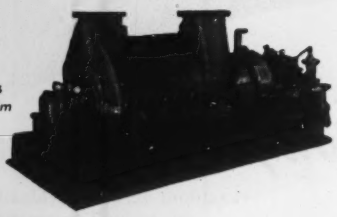
PUT *Specialists* TO WORK WHEN MOVING GAS OR AIR



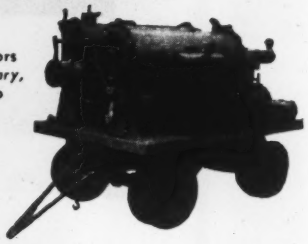
Rotary Positive Gas Pumps
5 cfm to 50,000 cfm.

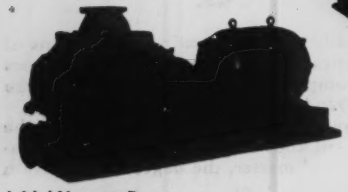


Centrifugal Blowers and Exhausters
Single and multi-stage, from 2,000 cfm to 100,000 cfm or higher.

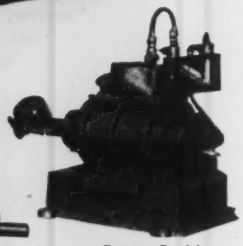


Inert Gas Generators
Portable or stationary, from 1,000 cfh to 35,000 cfh.





Cycloidal Vacuum Pumps
Single or 2 stage, from 500 cfm to 13,000 cfm, at vacuums up to 27" Hg.



Rotary Positive Displacement Meters
4,000 cfh to 1,000,000 cfh.

Rotary Positive Blowers and Exhausters
5 cfm to 50,000 cfm.

The job of handling gas or air for industrial operations is too vital for "catch-as-catch-can" methods. Where production and profits depend upon constant reliability of blowers, exhausters, vacuum pumps and related equipment, it's just plain good business to call on the specialists in such operations.

That has been Roots-Connersville's exclusive job for almost a century. Starting with the basic Rotary Positive principle, the R-C line has gradually been expanded to keep pace with industrial progress, new products and new manufacturing methods.

Besides being the only true specialists in handling gas and air, Roots-Connersville builds the only *dual-ability* line of Centrifugal and Rotary Positive units. With this exclusive *dual choice*, R-C engineers need never be committed to either type . . . but can recommend the equipment best suited to any specific job.

For your present or future requirements of equipment to handle gas or air, we suggest you consult the accepted specialists in this work.

ROOTS-CONNERSVILLE

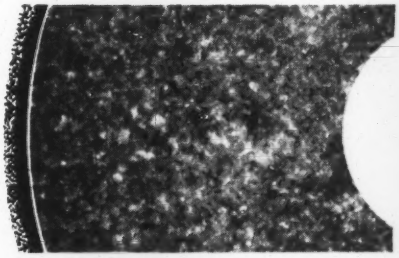
Exclusive Specialists in Handling Gas and Air

ROOTS-CONNERSVILLE BLOWER A DIVISION OF DRESSER INDUSTRIES, INC.
537 Michigan Ave. • Connersville, Indiana

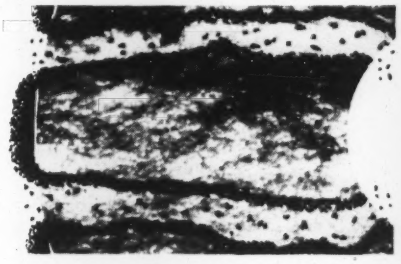
GRADUATED DENSITY

makes MICRO-KLEAN the most effective filter on the market!

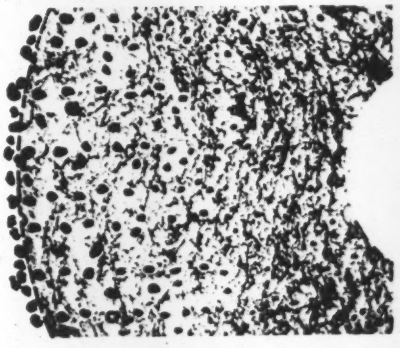
How MICRO-KLEAN compares with other cartridge filters



Compare MICRO-KLEAN with FILTERS WITH THE SAME DENSITY THROUGHOUT. The filter media density is the same on the pressure and discharge surfaces of the element; therefore, dirt accumulation is largely on the outside surface, choking the cartridge ("plastering") and reducing the effective filter life.



Compare MICRO-KLEAN with FILTERS WITH HAPHAZARD DISTRIBUTION OF FILTER MEDIA. Uneven haphazard media density permits fluid to find channels through the filter, and pass solids larger than the minimum filter spacing.



Now Look at the advantages offered by MICRO-KLEAN. See how the fibre density increases toward the discharge side of the MICRO-KLEAN filter cartridge? In effect, every Cuno MICRO-KLEAN cartridge is an infinite multiplicity of screens, ranging from relatively coarse on the outside down to 10 microns in the center. Because of MICRO-KLEAN's graduated density in depth, particles are entrapped within the entire depth of the filter element, giving the cartridge a much longer effective life. Standard cartridge size is 9¾" long by 2¼" O. D., in densities of 10, 25 and 50 microns.

MICRO-KLEAN gives you

- greater dirt holding capacity
- absolute protection against rupturing or channeling of the cartridge
- longer effective cartridge life

REMEMBER . . . IF YOU CAN PUMP IT, CUNO CAN FILTER IT

M.3.C

CUNO

ENGINEERED FILTRATION

Removes More Sizes of Solids From More Kinds of Fluids

AUTO-KLEAN (disc-type) • MICRO-KLEAN (fibre cartridge) • FLO-KLEAN (wire-wound)

COMPACT, FULL-FLOW FILTRATION FOR INDUSTRIAL FLUIDS

Fewer Cartridge Changes Necessary with MICRO-KLEAN filters

You don't need a complicated, bulky filter to keep contaminants out of your chemicals, water, lube or fuel oils. Cuno MICRO-KLEAN's compact construction gives you full-flow filtration in space which would limit ordinary filters to by-pass service.

The high porosity and low pressure drop operation of MICRO-KLEAN filters permit this full-flow service on gravity, low pressure, or suction lines—with no loss in operating efficiency.

Cartridge replacement costs are generally cut in half when MICRO-KLEANS are used. MICRO-KLEAN's graduated density-in-depth provides much greater capacity for dirt accumulation within the micronic cartridge, giving twice the useful life of an ordinary filter element.

Cuno's exclusive method of felting fibres produces a cartridge of great structural strength, free from channeling or distortion and entirely unaffected by moisture or acids. And changing cartridges can be accomplished in a few seconds—only one nut has to be removed.

Send for Cuno's free filtration analysis form, have one of your engineers fill it out, and mail it to us. We'll let you know exactly what you need for your filtration requirements—without obligation. And take advantage of Cuno's unique "money-back" offer. If MICRO-KLEAN doesn't outperform any filter cartridge you have previously used, we'll send you *double* your money back. Send the coupon today for free MICRO-KLEAN bulletin.

M.3.5

Cuno Engineering Corporation
Dept. 655C South Vine Street, Meriden, Conn.

I'm interested in your "money-back" offer. Please send me your filtration analysis form—and more information on MICRO-KLEAN for

..... (fluid)

Name.....

Company.....

Address.....

City.....Zone....State.....

PARKER Quality Die Castings—

make ERIE Double-Action Hand-Pumps a BETTER BUY!

PULL-PUSH! Only 2 inch piston travel and the new Erie double action piston type hand pump delivers up to 23 gallons per 100 short easy strokes. It's non corrosive inside and out, for the body is aluminum die castings by Parker. Die Castings were selected because machining costs were virtually eliminated . . . and die castings are lightweight and strong. Parker Die Castings are used profitably in nearly every industry. They are produced of exactly the right alloy to rigid specifications. Consult with Parker on your next die casting requirements. Take advantage of Parker's experience in producing highest quality die castings.

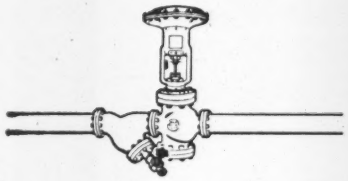
PARKER WHITE METAL COMPANY • 2153 McKinley Ave., Erie, Pa.

and when you think of Die Castings THINK OF

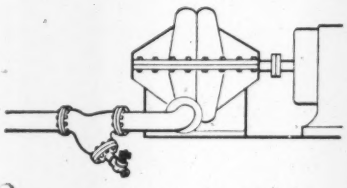
PARKER ALUMINUM and ZINC Die Castings

Which of over 150 Leslie strainers is the one for YOUR job?

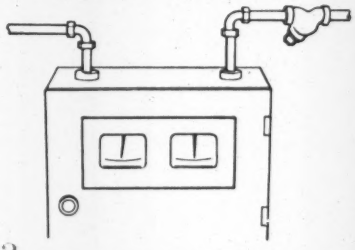
THREE "MUSTS" FOR GOOD PIPING PRACTICE . . .



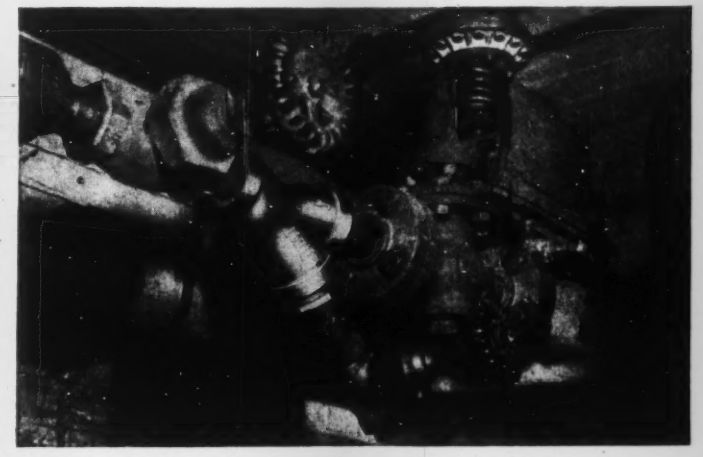
1. **For protection of control valves.**



2. **Protection of pumps, turbines and process equipment.**



3. **For superfine cleaning of air, steam and liquid flows, Leslie "Poromet" filters trap particles down to .001".**



WHICH WILL GIVE COMPLETE PROTECTION AT LOWEST COST?

Just considering strainer body material and screen specifications alone, there are over 150 *standard* combinations of "Y" type Leslie strainers. Each is engineered to do specific jobs under specific conditions . . . there's a "Leslie" for any industrial or marine pipeline strainer application.*

Then, with the myriad of pipe sizes and end connections, it's apparent that picking the right strainer to protect valuable equipment exposed to flow is *not* a "pin-the-tail-on-the-donkey" task.

*There are standard units for pressures to 2500 psi; temperatures to 1050° F; semi-steel, cast bronze, cast steel and cast alloy steel; screwed, flanged, welding or ring-type ends; sizes from ⅛" to 1".

RESERVE YOUR FREE COPY OF 12 PAGE BULLETIN 5308

soon to be released, showing strainer dimensions, pressure drop charts and pressure-temperature limit tables. Reserve your copy today. Write LESLIE CO., 287 Grant Ave., Lyndhurst, N. J.

It costs no more...

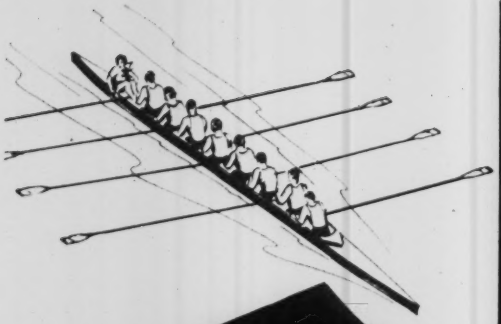
to get the right equipment for the right job. In fact, it costs less. It will pay to call your Leslie Engineer before specifying strainers... or any pressure, temperature or level control equipment. He's listed in the classified telephone directory in principal cities—under "Valves" or "Regulators."

PRINTED IN U. S. A. 2439

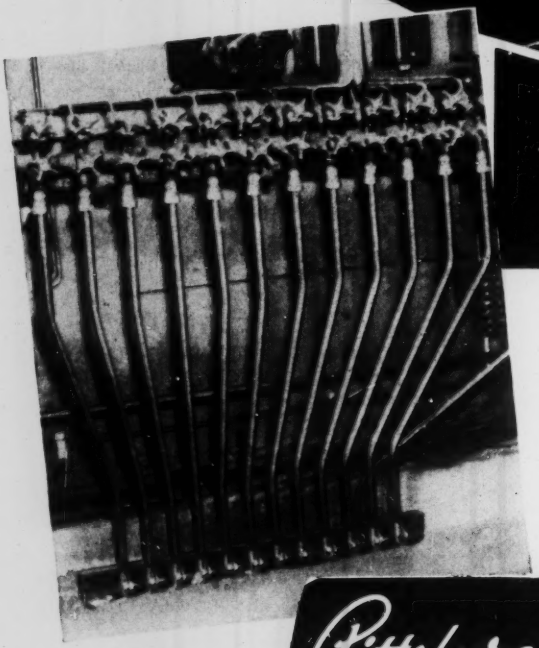
TRADE LESLIE MARK

THE FIRST NAME IN PRESSURE, TEMPERATURE AND LEVEL CONTROLS
Since 1900

LESLIE CO., 287 Grant Avenue, Lyndhurst, New Jersey



(S) TEAM WORK *Makes* STEAM WORK



Pittsburgh Piping GIVES SAME CAREFUL ATTENTION TO CONTROL PIPING THAT IS GIVEN TO MAIN STEAM LINES

The coxswain in a rowing scull is pint-sized — but he is the "control" that extracts smooth, flowing power from the bulging muscles of the oarsmen.

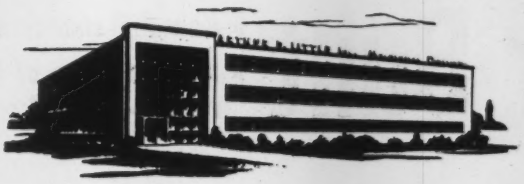
Control piping — a "small" part of a high-pressure, high-temperature system — plays an equally important part in performance. Like all parts of a P.P.&E. job — steam mains, headers and manifolds, bleed lines, etc. — it is engineered, fabricated, tested, and installed with precision.

The reason: 50 years of practice have taught us to know the tremendous importance of minute details. The result: Greater safety, smoother operation, and longer life in every P.P.&E. installation.

Pittsburgh Piping
AND EQUIPMENT COMPANY
10 Forty-Third Street — Pittsburgh, Penna.

Atlanta	Whitehead Building	Houston	Heights State Bank Bldg
Boston	10 High Street	New Orleans	P. O. Box 74
Chicago	Peoples Gas Building	New York	Woolworth Building
Cleveland	Public Square Building	San Francisco	785 Market Street

UNIQUE
PROTOTYPE DEVELOPMENT



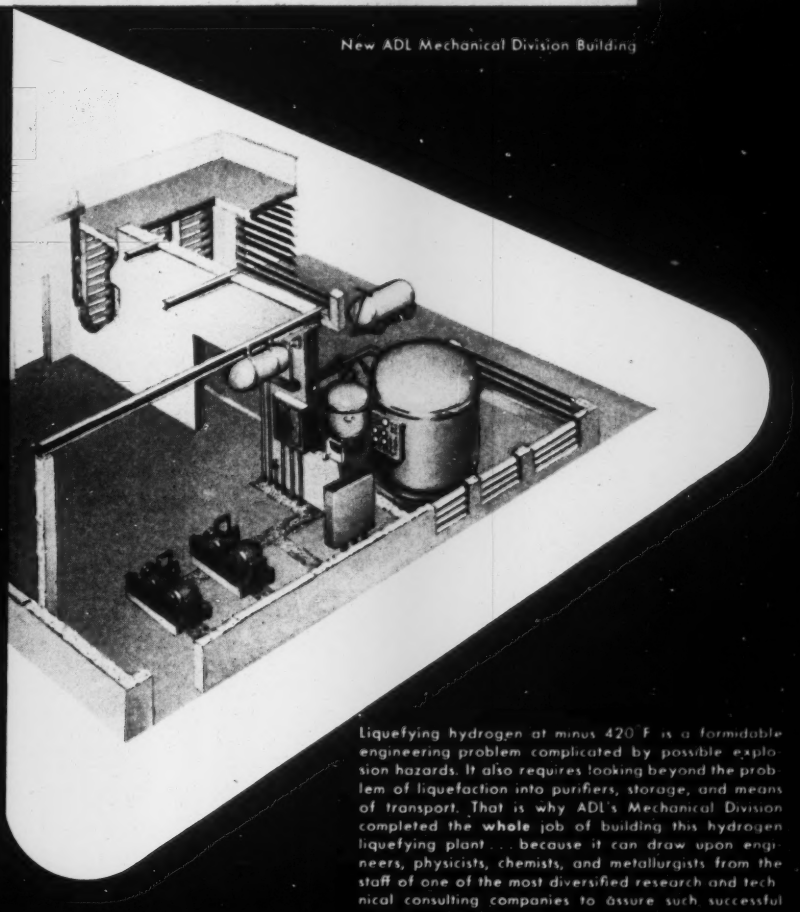
. . . using advanced engineering techniques

IF lack of personnel has halted development of your new ideas or new products, the ADL Mechanical Division can take over and bring them to complete maturity.

Arthur D. Little, Inc., has blended its scientific and engineering skills in the Mechanical Division to provide industry with a unique service . . . prototype development of equipment requiring a high level of engineering. Scientists in the fields of chemistry, physics, metallurgy, mathematics, biology, electronics and technical economics can be called on as required.

Our staff is experienced in interpreting the ideas of industry and following through with the perfection of specialized equipment.

New ADL Mechanical Division Building



Liquefying hydrogen at minus 420° F is a formidable engineering problem complicated by possible explosion hazards. It also requires looking beyond the problem of liquefaction into purifiers, storage, and means of transport. That is why ADL's Mechanical Division completed the **whole** job of building this hydrogen liquefying plant . . . because it can draw upon engineers, physicists, chemists, and metallurgists from the staff of one of the most diversified research and technical consulting companies to assure such successful prototype development.

THERMODYNAMICS · HEAT TRANSFER · REFRIGERATION TO MINUS 456 F · VACUUM ENGINEERING · GAS LIQUEFACTION · ELECTROMAGNETISM · MECHANICAL DESIGN · VIBRATION

Write for Brochure ME20-1

MECHANICAL DIVISION

Arthur D. Little, Inc.

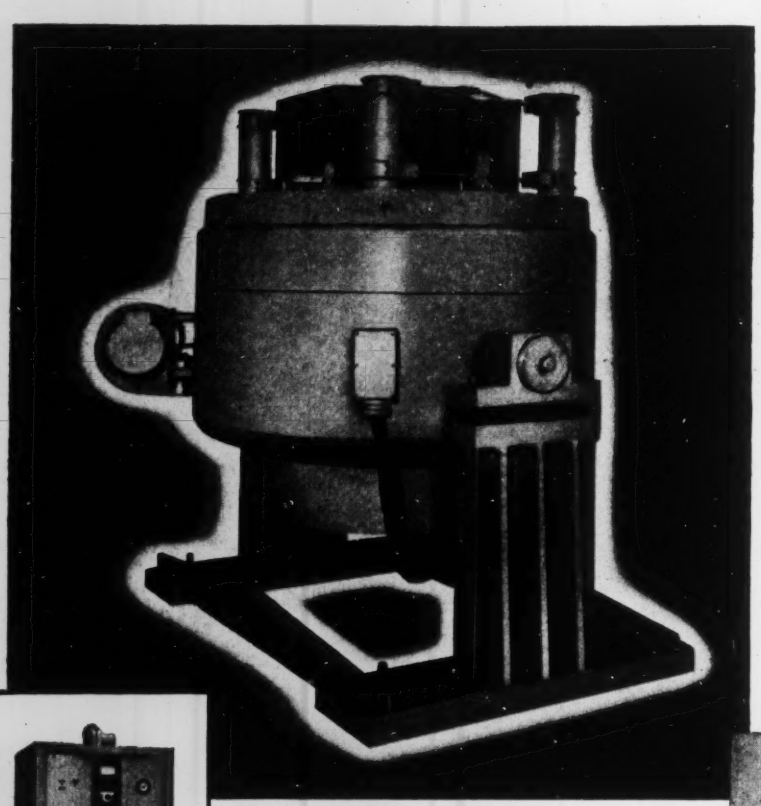
CREATIVE TECHNOLOGY SINCE 1886

ADL Mechanical Division

30 MEMORIAL DRIVE, CAMBRIDGE 42, MASS.

Largest Vibration Exciter Ever Built

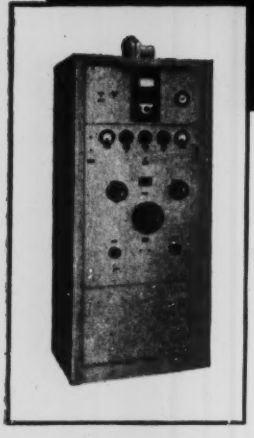
- *New MB shaker delivers 10,000 pounds force output!*
- *Widens scope of vibration testing to MIL-E-5272 and other specifications!*



HERE'S the latest—and the *largest* — vibration exciter ever built for shake testing. Developed by MB vibration specialists, this unit incorporates all the advances made in the last seven years for assuring dependable operation, pure table motion, and absence of resonances. These include specially designed table flexures, forced air cooling, built in protection against overtravel of the table and against misoperation of the equipment.

This extra heavy duty, conservatively rated, electromagnetic shaker has the capacity and endurance to permit continuous testing at rated output. It will handle anything from electrical components to air-frame structures.

Remember—available MB Vibration Exciters now range from 5 pounds output size all the way up to this new giant. Make MB your headquarters for help on vibration testing and other problems.



MODEL C-100 VIBRATION EXCITER has ½" total table travel. Flexure design supports heavy table loads without sacrificing stroke. Trunnion support permits operation in all positions from horizontal to vertical, and has built-in vibration isolation. Operating range: 5 to 500 cps.

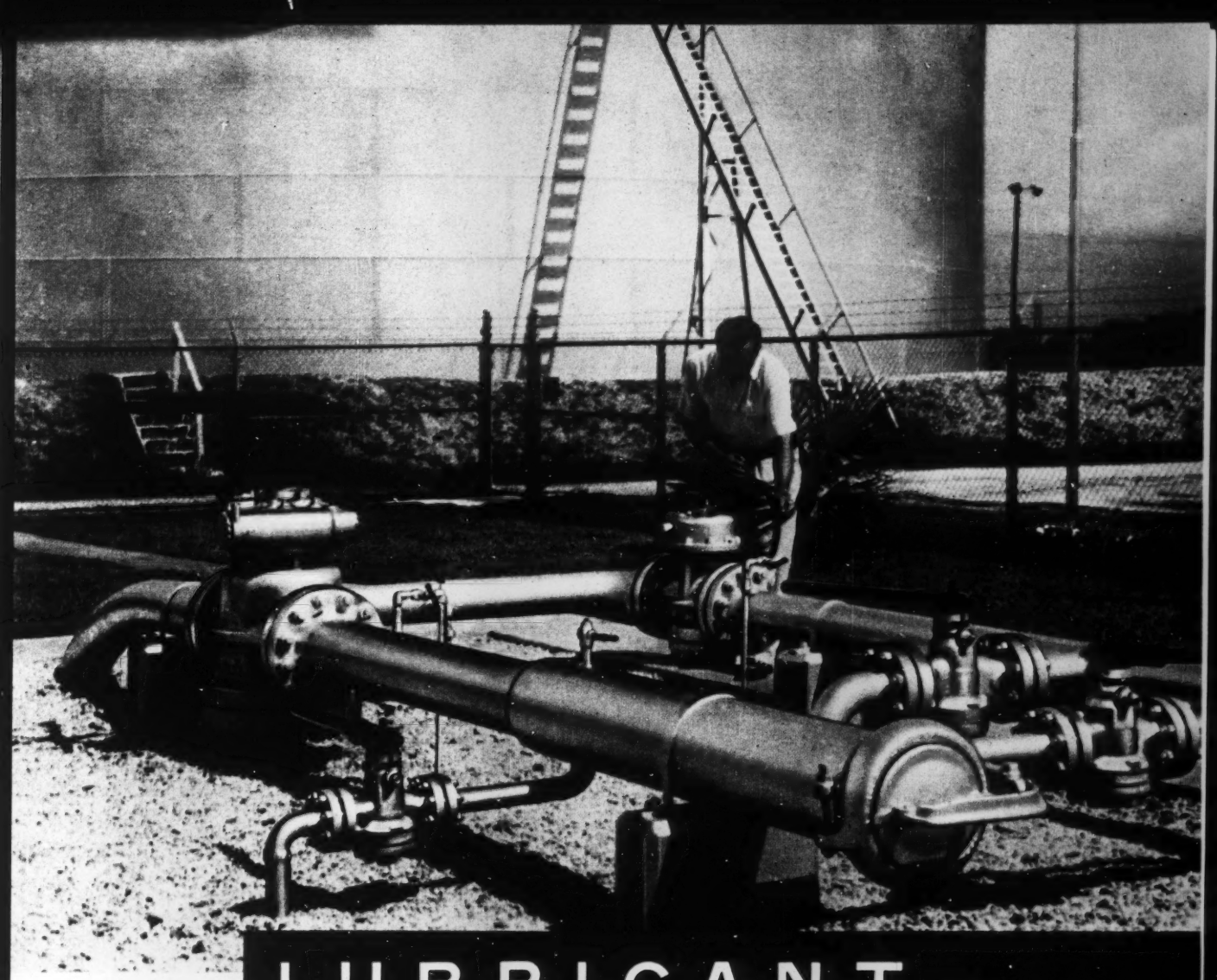
CONTROL PANEL (Model T-100) assures proper operation of equipment with interlocked controls. Accurate, easy, continuous control of force and frequency permits quick adjustments, or "scanning" over entire operating range. MB Vibration Meter provided; also running time meter.

ROTATING POWER SUPPLY rated to deliver full power without need for power factor correction. Blowers cool each unit separately. Alternators feed driver coil of shaker, with minimum harmonic distortion.

THE MB MANUFACTURING COMPANY, INC.
1060 STATE STREET, NEW HAVEN 11, CONN.

BULLETIN TELLS MORE
Contains specifications, operating information and helpful hints on usages of the complete line of MB Exciters. Write for Bulletin 1-VE-4.

PRODUCTS AND EQUIPMENT TO CONTROL VIBRATION • TO MEASURE IT • TO GENERATE IT



LUBRICANT—
THE NORDSTROM SEAL OF APPROVAL

In any valve, if a small leak starts, high repair and replacement costs are coming up. And, if the valve is in an often-operated manifold, trouble comes to a head sooner.

Unless . . . .

. . . . the valve is a Nordstrom.

Nordstrom valves have an extra seal against those small leaks. In Nordstrom valves, an even film of plastic lubricant surrounds the valve ports, sealing off the line fluid and at the same time filling any minute point of wear. Further, since there is no seat or disk in the eroding stream of flow, the chances for wear are cut to a minimum.

It's that extra seal of lubricant that has won approval for Nordstrom valves in hundreds of services where other valves aren't quite good enough.
Rockwell Manufacturing Company, Pittsburgh 8, Pa.

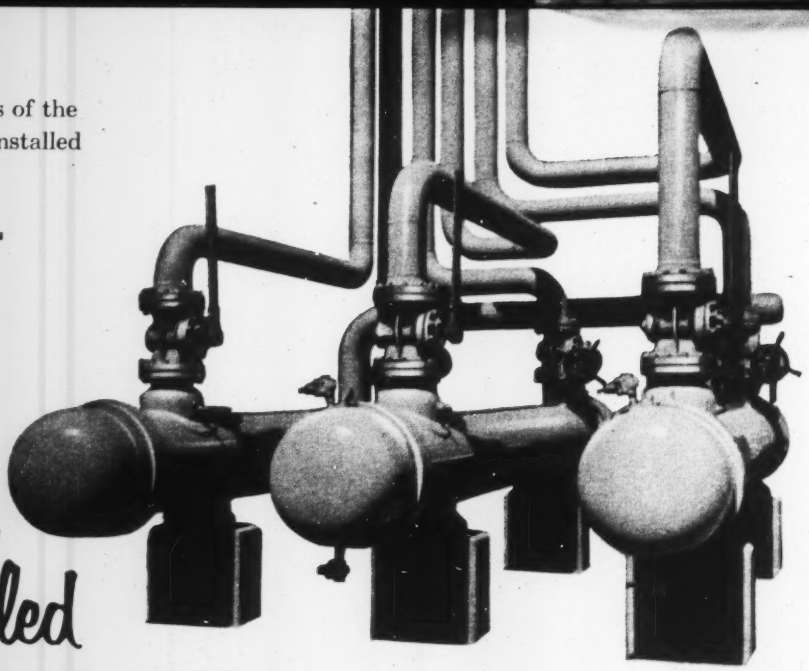
ROCKWELL Built Nordstrom Valves

Lubricant-Sealed for Positive Shut-Off

Another ROCKWELL Product

Regardless of the process, regardless of the piping arrangement, all valves are installed to do the same job:

TO CONTROL FLOW



Some valves do the job better than others. Some valves operate more easily than others in an emergency. Some valves stay tighter longer than others. That's because some (like these) are

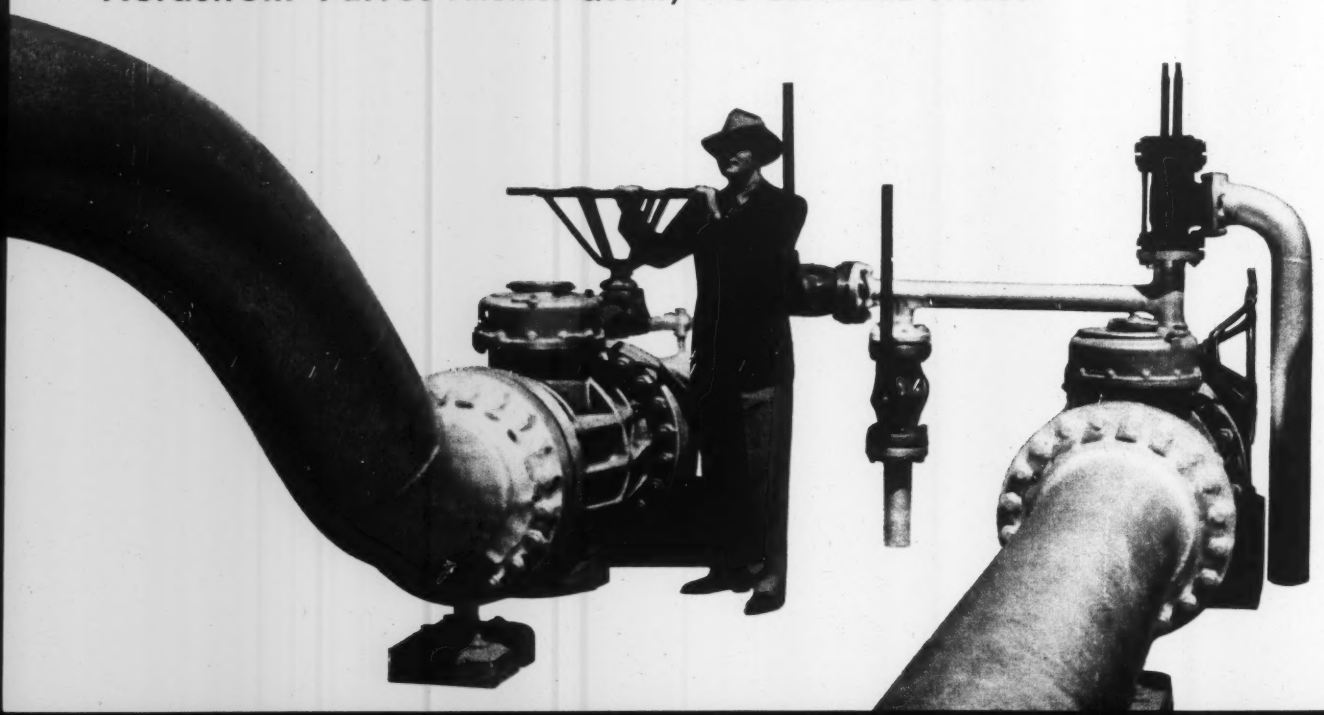
Lubricant-Sealed NORDSTROM VALVES

Nordstrom valves have a built-in lubricating system. The lubricant does two important things—it keeps the plug easy to turn so the valve shuts and opens in an instant when it is supposed to; it seals against the small leaks that become big and expensive and perhaps dangerous.
That's why Nordstrom valves

ARE YOUR BEST BUY

Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Nordstrom Valves Another Quality **ROCKWELL** Product



Blistering hot or sub-freezing cold— seal with LINEAR Silicone O-Rings

The scorching heat of a searchlight, and the bitter cold of the stratosphere, make short work of most flexible seals. Linear Silicone O-Rings, however, are ideally suited for these tough conditions. On the ground or in the air, these unique gaskets stand up over a range from −125°F. to +400°F. . . . . can even function at temperatures as high as 500°F. They resist compression set at high temperatures, and still retain their flexibility at the lowest extremes of service temperatures.

Excellent resistance to oxidation, moisture, thermal and mechanical shock are further qualities which have earned Linear Silicone O-Rings widespread use . . . in jet engine components, steam irons, outdoor floodlights, diesel engines and scores of other applications.

Whenever you need to design a seal that will withstand extremes of weather, which will not become brittle when cold or gummy when hot, investigate Linear Silicone O-Rings. They're precision-moulded from a selection of stocks. To simplify design— to lower costs—consult Linear for all your sealing needs.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

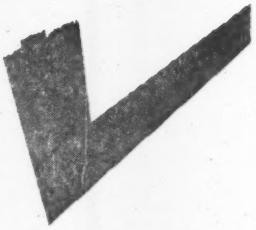
LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.

check the

dollars and sense reasons

for using HAGAN

automatic combustion controls



and HAGAN

ring balance flow meters

HAGAN
HALL
BUROMIN
CALGON

It makes good sense to invest your dollars in Hagan Combustion Controls and Hagan Meters. The investment pays real dividends in the following ways:

accuracy

Hagan Automatic Controls and Ring Balance Meters are accurate, whether the system is simple or complex. This accuracy is reflected in savings which, during the life of the boiler, usually amount to many times the cost of the equipment.

dependability

Hagan Controls and Ring Balance Meters are dependable in their performance, year after year. Long life and low maintenance costs are inherent in all designs.

versatility

One boiler or many, one or more fuels, Hagan Controls handle the job easily. Hagan Ring Balance Flow Meters are the most versatile meters available for measuring and recording flow of liquids and gases.

Whatever your metering or combustion control problems, let Hagan Engineers help you solve them. Our experience is at your service. Write, or call us, at

HAGAN CORPORATION

HAGAN BUILDING, PITTSBURGH 30, PA.

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
CONTROL SYSTEMS FOR AUTOMOTIVE AND
AERONAUTICAL TESTING FACILITIES

Communist machine-gun fire dropped him in combat. But whole blood kept him alive, saw him through the hospital. He thanks you for his life.

She'd been exposed to polio. A new serum, *Gamma Globulin*, made from blood, helped ward off the dread disease. She thanks you for her life.

A tornado whipped suddenly across her home town. She was badly injured by falling debris. But a quick operation, several transfusions pulled her through. She thanks you for her life.

Three grateful people say: "we're HERE... because you were THERE!"

Each one of these people is alive today because someone gave blood.

If you've given blood before, you know how easy it is—how quick and painless. And you know what a wonderful feeling it is when you realize that what you've done may give another person his life.

Now you are asked to give blood . . . again and again. And you can do it safely every 3 months.

Because America's need for blood has increased enormously—for our armed forces, for accident and disaster victims at home, for new disease-fighting serums.

Many a life hangs in the balance! Will you help? Call your Red Cross, Armed Forces or Community Blood Donor Center today!

BUSINESS EXECUTIVES CHECK THESE QUESTIONS

If you can answer "yes" to most of them, you—and your company—are doing a needed job for the National Blood Program.

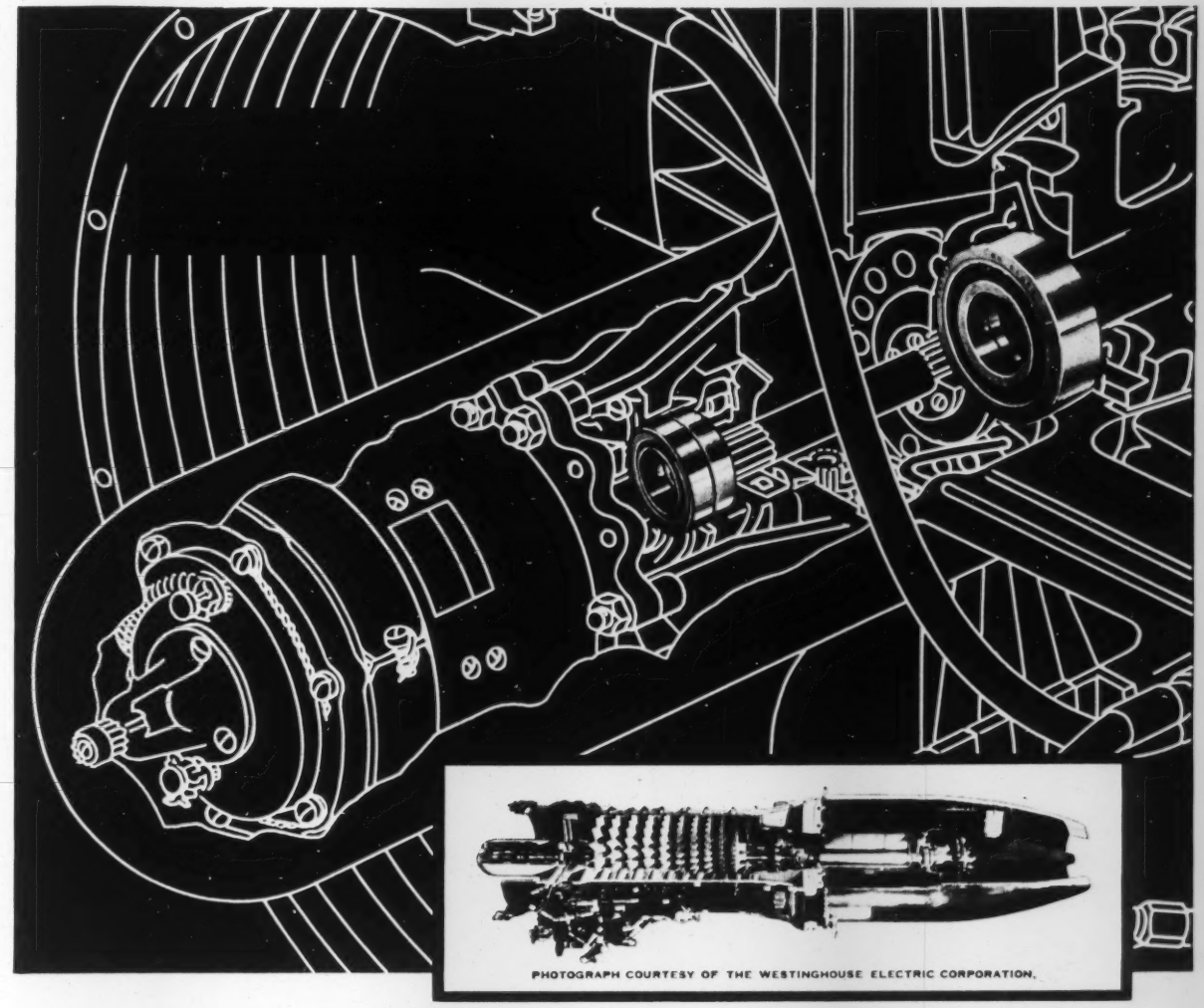
- ◯ HAVE YOU GIVEN YOUR EMPLOYEES TIME OFF TO MAKE BLOOD DONATIONS?
- ◯ HAS YOUR MANAGEMENT ENDORSED THE LOCAL BLOOD DONOR PROGRAM?
- ◯ HAS YOUR COMPANY GIVEN ANY RECOGNITION TO DONORS?
- ◯ HAVE YOU INFORMED EMPLOYEES OF YOUR COMPANY'S PLAN OF CO-OPERATION?
- ◯ DO YOU HAVE A BLOOD DONOR HONOR ROLL IN YOUR COMPANY?
- ◯ WAS THIS INFORMATION GIVEN THROUGH PLANT BULLETIN OR HOUSE MAGAZINE?
- ◯ HAVE YOU ARRANGED TO HAVE A BLOODMOBILE MAKE REGULAR VISITS?
- ◯ HAVE YOU CONDUCTED A DONOR PLEDGE CAMPAIGN IN YOUR COMPANY?
- ◯ HAVE YOU SET UP A LIST OF VOLUNTEERS SO THAT EFFICIENT PLANS CAN BE MADE FOR SCHEDULING DONORS?

Remember, as long as a **single** pint of blood may mean the difference between life and death for **any** American . . the need for blood is **urgent!**

NATIONAL BLOOD PROGRAM

GIVE BLOOD

...give it again and again



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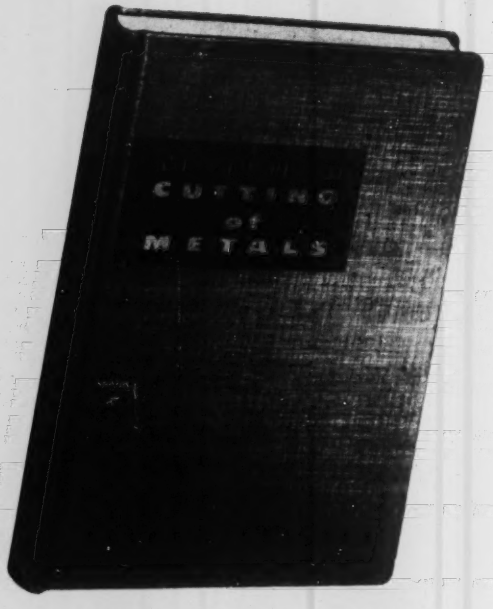
"SPIN FREEDOM" FOR TOMORROW'S JET ENGINES

Packing more power into less space . . . a trend in jet engine design . . . puts a premium on space-weight saving factors as well as performance. For "spin freedom" where every inch and every ounce counts, jet engine designers are turning to *Fafnir Super-Precision Ball Bearings.* In them, designers are getting "spin freedom" at a saving in weight and space . . . and they are getting proven performance too. These bearings, precision-built to millionths-of-an-inch tolerances, are now used at every important turning point on jet engines from main rotor to accessories and gear boxes.

Through continuous research and collaboration with aircraft design engineers, Fafnir keeps in step with aircraft developments . . . and maintains leadership in the production of aircraft bearings. The experience gained, adds to Fafnir's general fund of knowledge that contributes so much to the Fafnir "attitude and aptitude" . . . a way of looking at bearing problems from the designer's viewpoint, an ability to supply the right bearing for the need. The Fafnir Bearing Company, New Britain, Conn.



For all those engaged in production work

MANUAL ON CUTTING OF METALS

Providing, in 545 pages, a comprehensive coverage of all phases of machinability with respect to single-point cutting tools.

Written in collaboration with twenty-two specialists, this new Second Edition of the Manual enlarges upon the first (published in 1939) in that it incorporates a more descriptive presentation of tool materials and their treatment; of work materials and the relations of their behavior and properties to microscopic structure; and much new material on the types, purposes, and application of cutting fluids.

Additionally, there are extensive new tables giving both unit horsepower and machinability ratings for a great number of steels of various hardnesses for specific tools and cuts; and charts for determining the speeds for further combinations of cut, tool shape and material hardnesses. Specifications for many of the materials covered in the new tables are for the most recent revisions of mechanical properties.

The tabular data on cutting speeds and horsepower of the first edition are retained because of their comprehensiveness.

All this information has been gathered in one compact volume for your use.

- Types, uses and preparation of single-point tools—American Standard nomenclature, standard types and sizes of tools, tips, inserts, and holders; tool materials, grinding, evaluating tool performance.
- Mechanical characteristics and structures of work material—Influence of metallurgical structure on machinability, chip formation and control, factors influencing surface finish.
- Definitions, functions and classification of cutting fluids—Influence on cutting speeds, best ratio of depth to feed, practical cutting fluid recommendations.
- Cutting forces; gross and net power at the cutter—Tools, speeds and feeds for machining a variety of metals, including high nickel alloys, stainless steels, copper alloys, cast iron, and plastics.
- Net unit power for machining a great number of metals using a single size of cut—Formulas for computing power required for other cuts, correction factors for various tool angles, computation of motor capacity requirement.
- Economics of metal cutting—Costs of cutting, idle and loading time, tool changing, and grinding; cost per piece formula, calculation of minimum cost per piece, and of tool life for maximum production rate.
- Tabular data—Specifically 322 tables covering the machining of thirty-five commonly used steels by seven differently shaped tools; the cutting speeds and the horsepower required for seven speeds varying from 0.002 to $^1/_8$" each for nine depths ranging from $^1/_{32}$ of an inch to one inch; an extensive table from which values may be derived for a more complete list of 289 steels and conditions; and other tabular data for computing similar information about the turning of 27 cast irons and 34 nonferrous metals.

Cloth bound $10.00 (20% discount to ASME members)

Order Your Copy Today From

The American Society of Mechanical Engineers

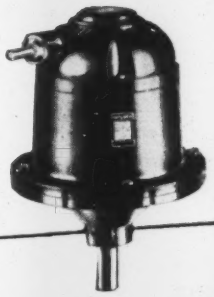
29 West 39th Street, New York 18, New York

SHOPMEN will find in this Manual the ready information they want.

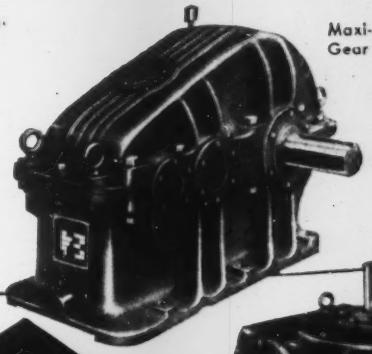
PRODUCTION EXECUTIVES can look to it for help in selecting the structure of metals to be machined, the correct tool material, the size and shape of cut, the proper cutting fluid, and in predetermining the power requirements and best operating speeds for all jobs.

TIME STUDY MEN can use its data on optimum cutting conditions to formulate operating standards and predict production costs.

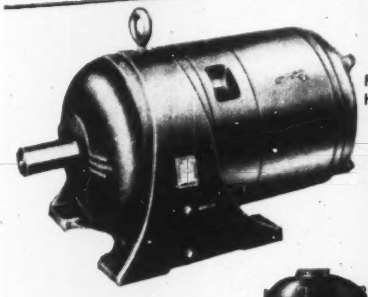
Line-O-Power
Straight Line Drive
(Foot Mounted)



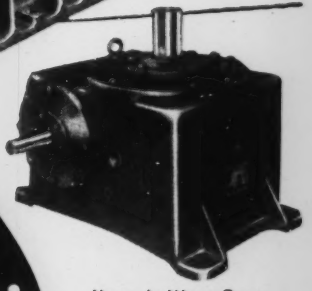
Line-O-Power Right Angle
Drive (Flange Mounted)



Maxi-Power Helical
Gear Drive



Foote Bros.-Louis Allis
Horizontal Gearmotor



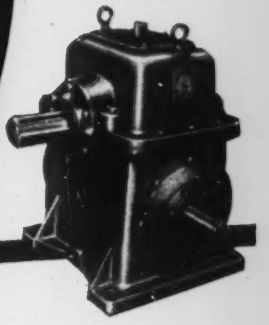
Hygrade Worm Gear
Vertical Drive

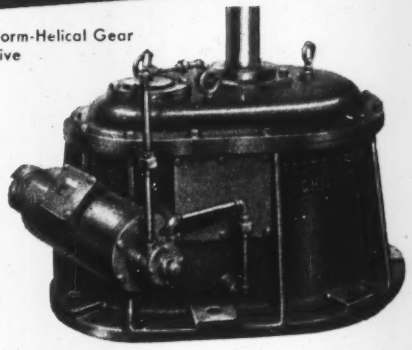
name your job...

FOOTE BROS. DRIVES WILL HANDLE IT!

Foote Bros.-Louis Allis
Vertical Gearmotor

Hygrade Worm Gear
Horizontal Drive





Worm-Helical Gear
Drive

At Foote Bros. you will find a complete line of enclosed helical and worm gear drives for every job. Ratios and capacities to answer every speed reduction need. Also available to assure long and satisfactory service is a complete line of Foote Bros.-Louis Allis Gearmotors, both vertical and horizontal.

Foote Bros. offers these advantages: Nearly 100 years of design, engineering and manufacturing experience—the latest in gear-cutting techniques—better control of materials. Modern production techniques at three large plants assure superior drives for every power transmission requirement.

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Better Power Transmission Through Better Gears

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☐ Hygrade Drives ☐ Worm-Helical Gear Drives
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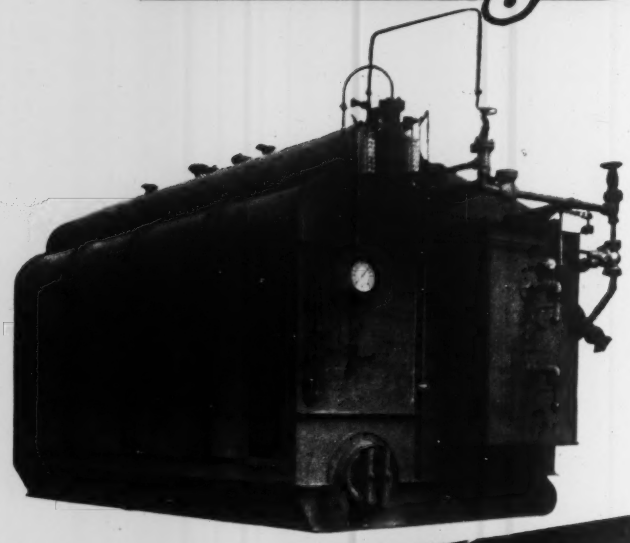
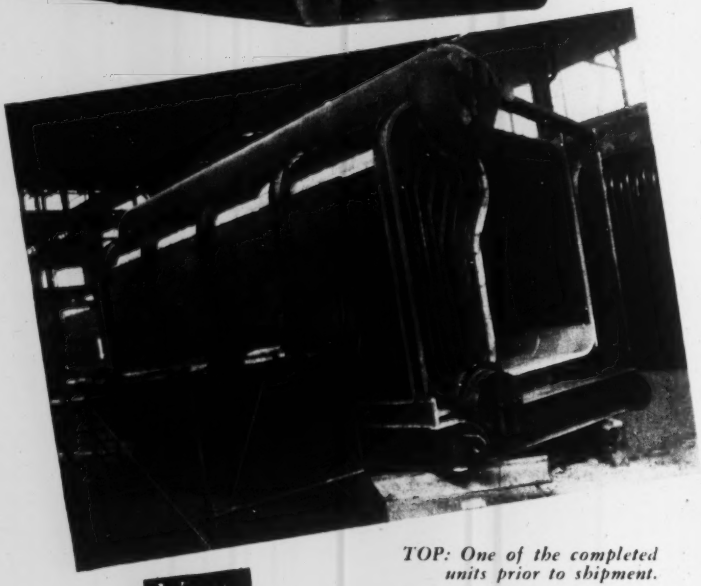
City.....*Zone*.....*State*.....

Vogt

Gas Fired
PACKAGE UNIT
Steam Generators
selected by
PHILLIPS CHEMICAL CO.
Pasadena, Texas Plant





TOP: One of the completed units prior to shipment.

BOTTOM: Shop erection view shows tile and block insulation in convection wall; also main baffle tile and furnace floor tile.

Principal Data, Each Unit

25,000 pounds steam per hour capacity. Induced draft type.
Fusion welded steam and water drums designed for 425 pound S.W.P.
Completely shop assembled and required only the piping and gas outlet connections to place them in operation.
Fully steel encased for outdoor installation on a simple foundation.

●

**Vogt Steam Generators are available in bent tube types and straight tube forged sectional header types for solid, liquid or gaseous fuels. Bulletins on request.*

HENRY VOGT MACHINE CO.
Louisville, Kentucky

BRANCH OFFICES: New York, Philadelphia, Chicago, Cleveland, St. Louis, Dallas, Charleston, W. Va.

You get MORE CAPACITY with a FANMIX BURNER

Increase Boiler Ratings On Present Or Planned Equipment

In all types of Coppus-Dennis FANMIX Burners — straight gas or combination gas-oil — we utilize the energy of the fuel under pressure to drive the burner fan and deliver air in the proper proportion to the fuel flow. This exclusive "pinwheel action" *mechanically* mixes fuel and air in exactly the right proportions for truly radiant, non-luminous heat.

The result is uniform temperature everywhere in the combustion chamber — no drifting "hot spots" — and complete combustion under all conditions. That's why you can release more heat into your present furnace — why in new installations you get more heat into smaller furnace space.

FANMIX Saves On Both Old and New Installations

FANMIX can easily be operated with your present furnace and stack, requiring only minor changes in other equipment. Or if you're planning on new boilers, remember that FANMIX relieves the furnace from the burden of mixing, creates its own forced draft and takes smaller pipe sizes. Which means you can plan on reduced combustion space, less stack, no forced draft equipment and lower installation costs all around.

Get the Whole Story

Coppus engineers FANMIX Burners to meet individual requirements, providing complete control over heat pattern and combustion . . . Learn more about how "pinwheel action" can step up *your* boiler performance to peak efficiency and economy — as it is doing throughout industry. Send for Bulletin 410-6. Coppus Engineering Corp., Worcester 2, Mass. Sales Offices in THOMAS' REGISTER. Other Coppus "Blue Ribbon" Products in BEST'S SAFETY DIRECTORY, CHEMICAL ENGINEERING CATALOG, REFINERY CATALOG, and MINING CATALOGS.

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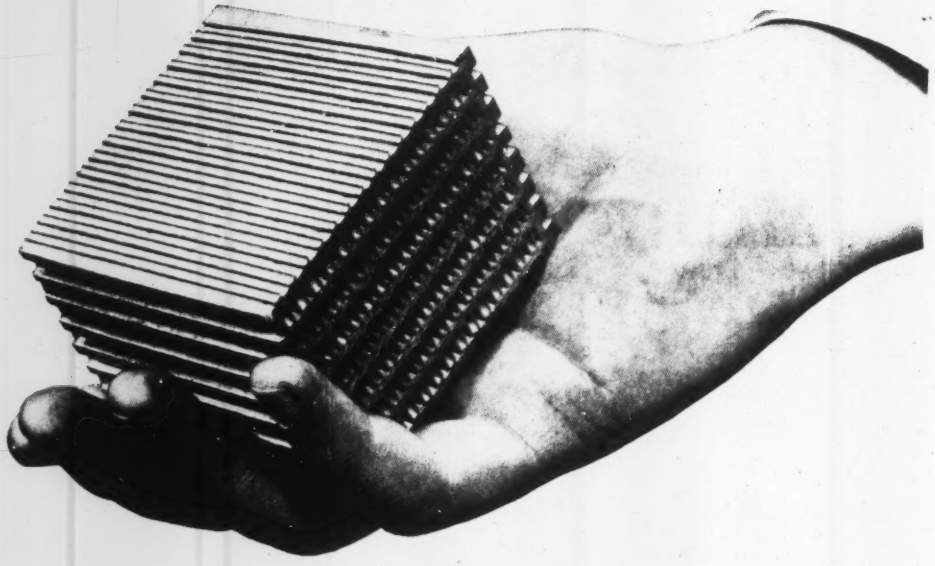


This sample section of a TRANE Brazed Aluminum Heat Exchanger shows how its construction can pack up to 450 sq. ft. of surface into a single cu. ft. of space.

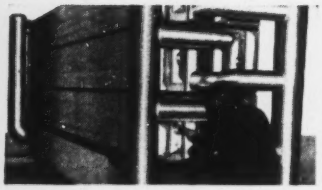
Is this your key to a new product or process?

New TRANE Brazed Aluminum Surface makes NEW products and processes not only possible...but practical. Here's why:

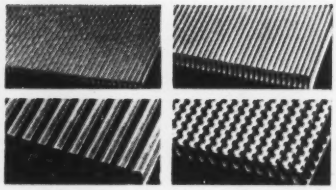
1. Wider range of core sizes and shapes.
2. Greater variety of surfaces.
3. Almost unlimited design flexibility.
4. Up to 9 times more surface for the heat exchange job than with conventional ¾" shell-and-tube construction.
5. Light weight. Yet takes test pressures up to 1,000 lbs. per sq. inch and temperatures from −300° to 500° F.
6. Can handle 5 fluids or more at one time.
7. Can produce more heat transfer in ¼ the space, with ⅓ the weight.

What's your heat transfer problem? Liquid-to-liquid, gas-to-gas, liquid-to-gas? Condensing and vaporizing fluids? You may find a new and better solution in this new kind of all-aluminum heat transfer surface . . . developed by TRANE.

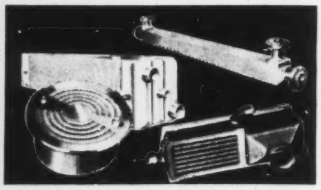
Write on your company letterhead for your FREE copy of "Extended Surface Heat Transfer Equipment."



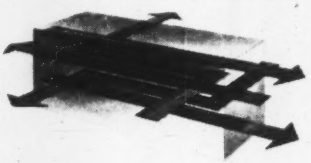
On large or small jobs, TRANE Brazed Aluminum Heat Exchangers can solve almost any heat transfer problem. Multiple-core units can be furnished. You can get temperature approaches of 5° to 10° F.



Select the surface you need. Straight and continuous, serrated, herringbone or perforated. Height, thickness and fin-spacing also can be varied to meet required heat transfer and pressure drop performance.



Design flexibility makes possible heat exchangers in many shapes . . . and in sizes up to 106" in length, with either bolt-on or integrally welded headers. For longer flow lengths, cores can be welded together in series.



Handle up to 5 fluids or gases, even more, at once. This symbolic drawing shows how. If your job requires one stream or many—high or low temperatures or pressures—solve it with TRANE Brazed Aluminum Heat Exchangers.

More heat exchange . . . closer temperature approaches

TRANE brazed aluminum heat transfer surface

The Trane Company, La Crosse, Wis. • East. Mfg. Div., Scranton, Penn. • Trane Co. of Canada, Ltd., Toronto • 87 U.S. and 14 Canadian Offices

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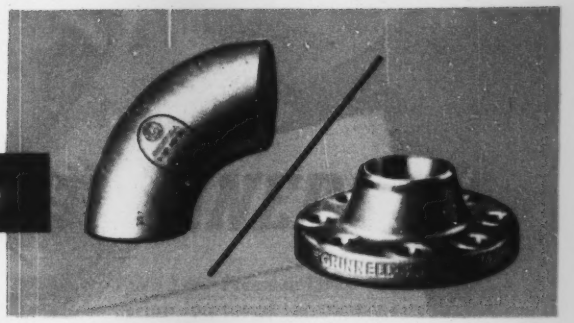

GRINNELL

STAINLESS STEEL WELDING FITTINGS and FLANGES

To help combat mounting costs in the installation and maintenance of piping systems where corrosive or certain other service conditions are involved, Grinnell offers a comprehensive range of welding fittings and flanges in stainless steel.

- **To prevent corrosive attack.**
- **To obtain adequate impact resistance at low temperatures and sufficient creep strength at high temperatures.**
- **To provide sanitary conditions.**
- **To avoid contaminating the product.**

Grinnell welding fittings and flanges are available in types 304, 347 and 316. These are in the chromium-nickel grades known as "18-8". The corrosion resistant properties of stainless steels are primarily due to the chromium content which ranges from 17% to 20%. The addition of nickel in ranges from 7% to 14% improves the corrosion resistance as well as the properties at elevated temperatures. A molybdenum addition of 2% to 3%, as found in type 316, increases the resistance to sulphurous and phosphoric acids, brine and hypochlorite solutions, and improves the general resistance to other corrosive liquids, as well as improving the physical properties at elevated temperatures. A columbium addition of approximately 0.4% to 1.0%, as found in type 347, creates non-susceptibility to carbide precipitation which can cause intergranular corrosion.

In addition to stainless steel, Grinnell offers welding fittings and flanges in carbon steel, nickel, Inconel, Monel, aluminum and brass.

Write for new booklet giving complete data on Grinnell stainless steel welding fittings and flanges. No obligation.

stainless steel welding fittings
Types 304, 347, 316

DESCRIPTION	SCHEDULE†	PIPE SIZE, IN.‡
90° Long Radius Elbow 45° Long Radius Elbow 180° Long Radius Return Straight Tee	5s, 10s, 40s, 80s	½ to 12
Reducing Tee	5s, 10s, 40s, 80s	¾ to 12
Cross (Straight and Reducing)	5s, 10s, 40s, 80s	1¼ to 12
Concentric Reducer Eccentric Reducer	5s, 10s, 40s, 80s	¾ to 12
Lateral (Straight or Reducing)	5s, 10s, 40s, 80s	1 to 12
Cap	5s, 10s, 40s, 80s	½ to 12
Lap Joint Stub End-Long	10s, 40s, 80s	½ to 12
Lap Joint Stub End-Short	5s, 10s, 40s,	½ to 12

† 5s is Featherweight, 10s Lightweight, 40s Standard, 80s Extra Strong.
‡ Larger sizes available on special order.

stainless steel flanges

150 lb. and 300 lb. Steel Flange Standard *(Higher series available on application).*

DESCRIPTION	PIPE SIZE, IN.
Welding Neck Slip-on Lap Joint Threaded Socket Type Blind	½ to 24

150 lb. Corrosion Resistant Standard. *(For use with schedule 10s and 5s pipe. Rated at 150 psi at 500°F, 225 psi at 150°F, when used with full-faced gaskets).*

DESCRIPTION	PIPE SIZE, IN.
Buttwelding Slip-on Blind	½ to 12

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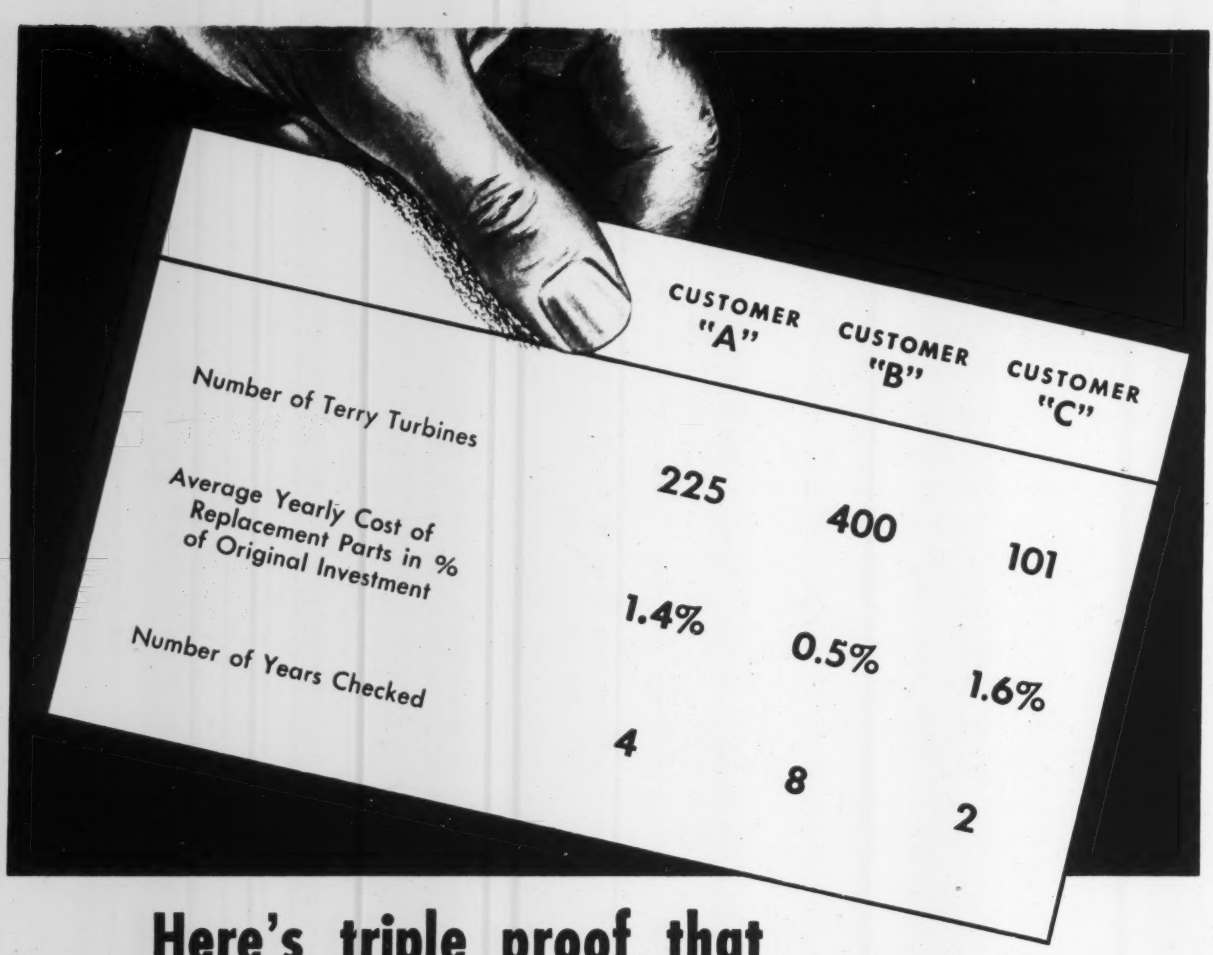
WHENEVER PIPING IS INVOLVED

Grinnell Company, Inc., Providence, Rhode Island • **Coast-to-Coast Network of Branch Warehouses and Distributors**

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems



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IT PAYS TO SPECIFY TERRY TURBINES

When you combine the figures for these three customers — a total of 726 turbines — the average yearly cost of replacement parts works out to only 1.1% of the original investment. A truly remarkable record, even when you realize that they are Terry turbines.

But, the cost of replacement parts is only the beginning of the story. The real savings are in the labor costs and production losses which are reduced so drastically when you install Terry turbines.

Send for further information about these low-maintenance turbines. Bulletin S-116 describes the many advantages of the Terry solid-wheel turbine. For multistage turbines, ask for a copy of Bulletin S-146.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TT-1196

You can maintain more of the FULL-RATED PRESSURE

with ZURN Engineered Low Pressure Drop STRAINERS

Plug Relieving Yoke assures easy valve operation since the plug can be unseated before turning.
"C" washer and yoke cover closures facilitate rapid cover removal for cleaning.
Minimum open area ratio of 6 to 1 maintained even though selected basket material may be only 30% open.
Eccentric location of baskets creates a flow cross-section proportional to the flow at all points in the screen cavity, thus reducing turbulence and flow resistance at that critical point.

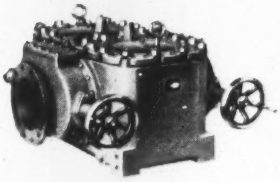
Zurn Low Pressure Drop (LPD) Strainers are design improved for correct circularity. They have ample waterways; smooth inner walls; correctly sized and perforated baskets, eccentrically positioned, all of which combine to reduce pressure loss and afford maximum protection for all types of mechanical units connected with pipe lines. Zurn LPD Strainers are held to close tolerances for materials, shapes, and dimensions, assuring the utmost in strength and safety and continuous operation.

Zurn LPD Strainers are widely used to protect close-tolerance control devices and delicate mechanisms, also to protect product purity. They make continuous production processes possible.

Zurn LPD Strainer applications include fluid handling lines for lubricating and fuel oil, and oil during the refining process; a wide range of chemicals produced and used by the various process industries; public utility power plants; power stations; industrial plants; ships and high-temperature installations. Zurn Fluid Handling Engineers are available for consultation on your particular problem.

J. A. ZURN MFG. CO.
INDUSTRIAL DIVISION
ERIE, PA., U.S.A.
In Canada: Canadian Zurn Engineering Ltd., Montreal 25, P. Q., Canada

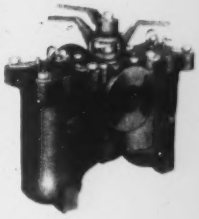
There is a ZURN LPD strainer for every fluid handling purpose



Zurn Duplex Gate Type Multi-Basket Strainer.

Zurn Sinlex Strainer. Available in offset and straight-through types.

Zurn "Y" Type Strainers available in any cast material and for high pressures.



Zurn Duplex Plug Type Strainer.

Zurn Engineered Low Pressure Drop Strainers are patented and patents pending.

WRITE FOR LPD STRAINER MANUAL DATA NO. 952

This manual includes previously unpublished pressure drop data and gives useful, factual information on fluid handling.

J. A. ZURN MFG. CO.
Industrial Division, Erie, Pa., U. S. A.
Please send me Zurn LPD Strainer Manual Data No. 952.

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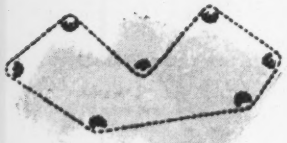
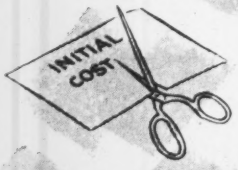
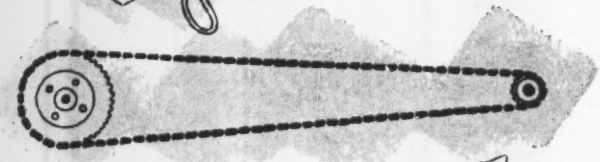
If Your Design Problem

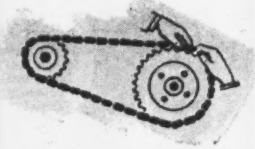
design flexibility  dependability

low initial cost 

low overall cost

long centers  short

positive timing heat

ease of installation  long life

Chain Is Your Answer

Yes, chain will solve any of these problems in both drive and conveyor service. The important point is to be sure you select the best chain to do the job. That's why so many designers make their selections from the complete Chain Belt line.

In the complete Chain Belt line there are literally hundreds of sizes and types of chain . . . but only one can be the *best* chain for your particular application. For example: for a high speed drive, Baldwin-Rex® Roller Chain is probably most efficient. For conveying cans, bottles, and jars

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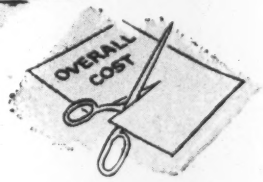
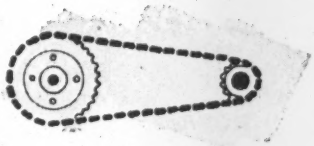
saving weight

saving space

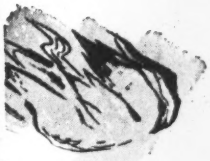


low maintenance cost

centers

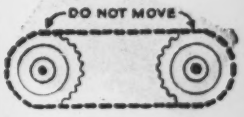


constant speed ratios



cold

fixed centers



resistance to dirt, grease, grit

you choose between Rex TableTop® and Baldwin-Rex PlateTop, depending on load conditions; where loads are heavy and chain must operate in dust and dirt, some type of Rex Chabelco® is usually indicated.

Our Rex Field Sales Engineers are specially trained to help you with your chain selection problems. For more help, call your nearest Chain Belt branch office or write to Chain Belt Company, 4765 W. Greenfield Ave., Milwaukee 1, Wisconsin.

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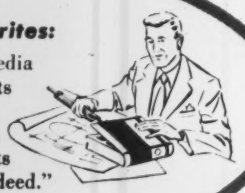
Use it as a regular encyclopedia to find the products and vendors. Since my particular work is design of new products this is very helpful indeed."



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"We often use the catalog to help select sources for equipment when we are engaged for plant layout or material handling assignments."

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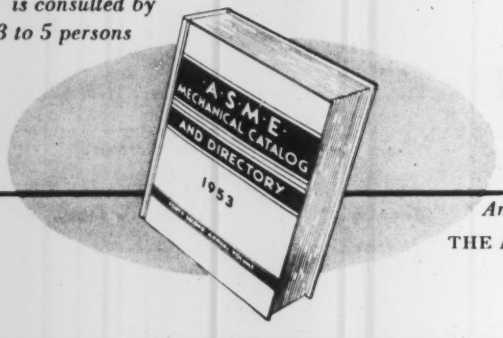
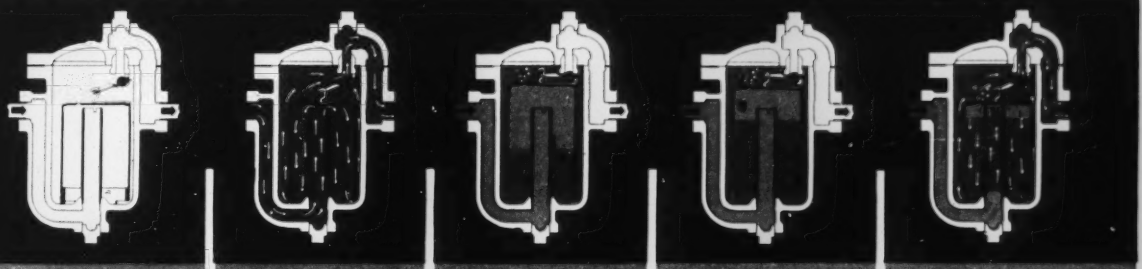
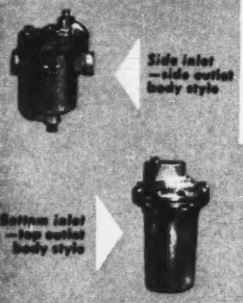


ARMSTRONG TRAPS are Designed to give Outstanding Performance



1. When trap is installed, inverted bucket is down and valve is wide open.



2. When steam is turned on, condensate (solid color) flows into trap and out orifice, until . . .

SELF-SCRUBBING ACTION (See Fig. 2 above). Note that condensate first flows down between bottom of bucket and trap body, then up and out through orifice. The high velocity flow under bottom of bucket keeps dirt in suspension, washes it out when trap opens. No dirt problems with Armstrong design.

3. . . . steam (light color) reaching the trap floats the inverted bucket and closes the valve.

BUCKET FLOATS WHEN LESS THAN ½ FULL OF STEAM (See Fig. 3 above). The generous margin of safety (dimension A in Fig. 3 above) insures that the bucket will float with trap body partly full of water. A heavier bucket would give more power but it might float and close the valve.

4. When more condensate enters, bucket loses buoyancy and pulls on valve lever.

NO AIR BINDING (See Fig. 4 above). Air mixed with steam passes through the bucket vent, collects at top of trap and is discharged ahead of condensate. The large air-handling capacity of Armstrong traps insures top equipment temperatures and faster heat-up.

5. When weight of bucket times leverage overcomes pressure on valve, trap opens.

EXCESS POWER FOR OPENING (See Fig. 5 above). Armstrong design provides a generous safety margin. Reducing dimension B in Fig. 4 would increase power of bucket but margin between test opening pressure and operating pressure would be too low to allow for normal wear and pressure fluctuations.

THE highly efficient design of modern Armstrong traps reflects over 40 years' experience in inverted bucket trap manufacture and application.

ARMSTRONG design offers:

- A "frictionless" leverage system which combines high leverage with wide opening of a large orifice.
- A minimum of parts.
- Strong, corrosion-resistant and wear-resistant materials.
- Generous margins of safety.

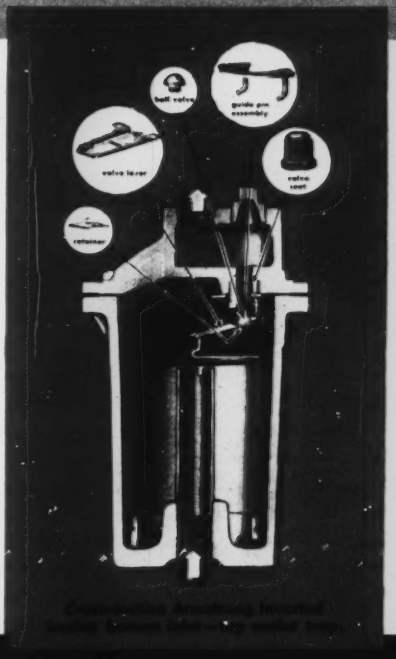
FOR TRAP USERS this means:

- Large capacity.
- Dependable service under adverse operating conditions.
- Low maintenance.
- Continuous operation of heating and process equipment.

The soundness of Armstrong design has been proved in thousands of plants all over the world. To insure dependable condensate drainage simply specify: "Traps shall be Armstrong." For additional information, call your local Armstrong Representative or write:

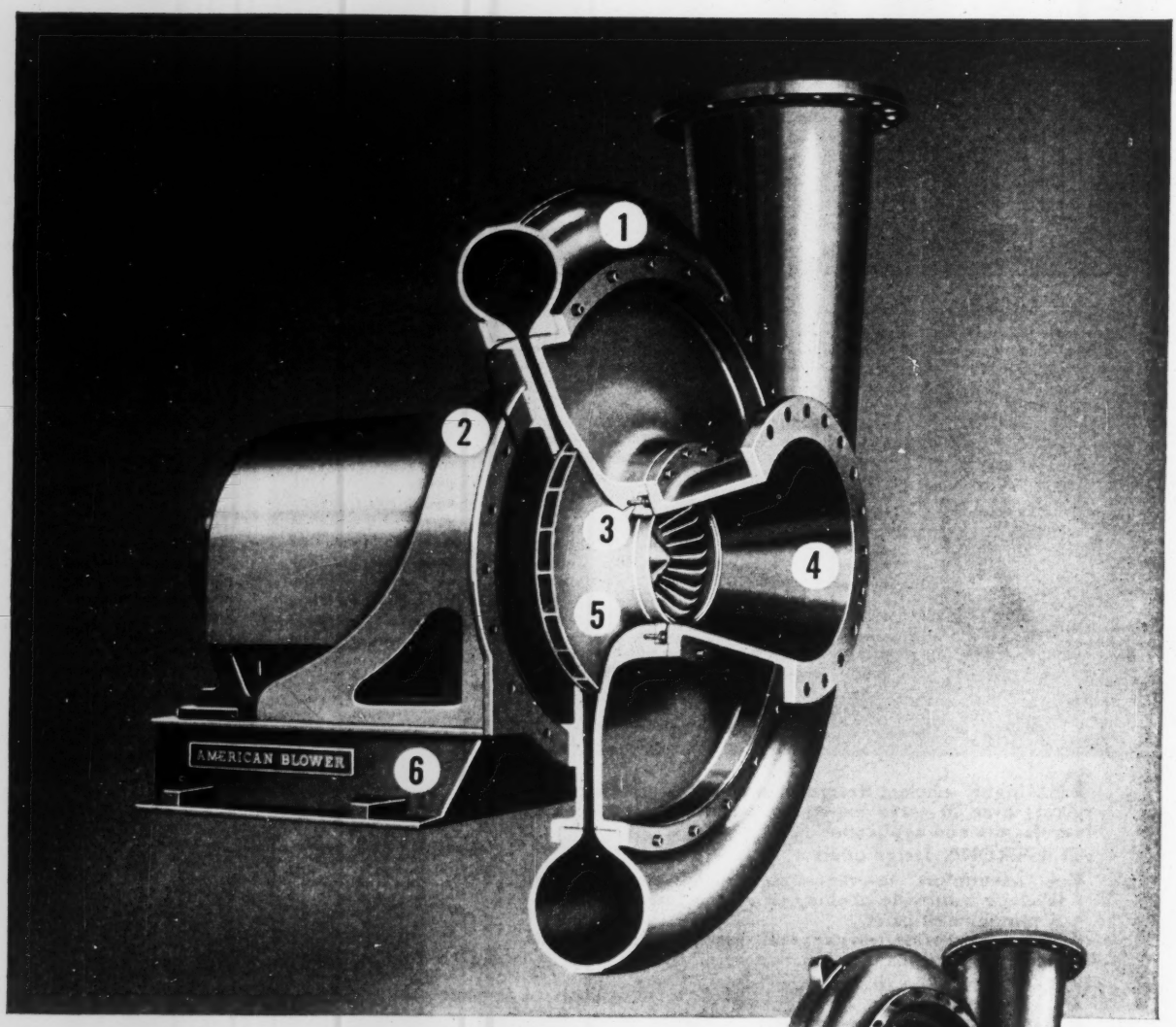
ARMSTRONG MACHINE WORKS
894 Maple Street, Three Rivers, Michigan

● ***SEND FOR*** **NEW 44-PAGE STEAM TRAP BOOK.** Complete data on Armstrong trap design and operation; physical data and list prices; capacities; selection, installation and maintenance recommendations Free on request.

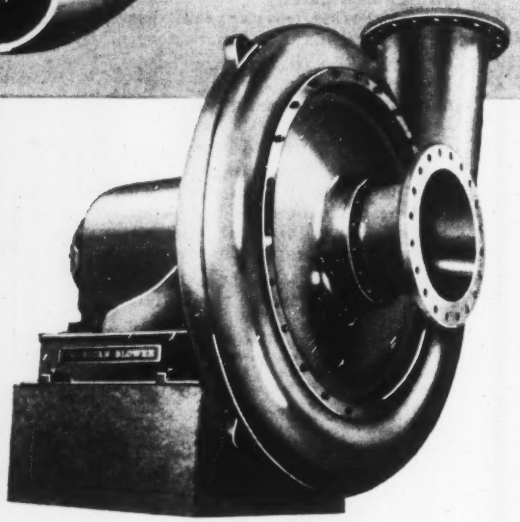


ARMSTRONG STEAM TRAPS

American Blower...a great



In cutaway view above: (1) Improved scroll-shaped casing design results in increased compressor efficiency. (2) Unobstructed, long diffuser passage converts velocity energy into pressure; provides quiet operation. (3) Annulus packing minimizes recirculation of gas around impeller inlet. (4) Removable inlet nozzle assures accurate alignment of annulus packing when assembled with impeller. (5) Aero-dynamic design of impeller blades results in high efficiencies, long life. (6) Welded steel baseplate is "stress relieved" prior to machining—assuring maintained alignment.



name in air handling, *offers you*

An outstanding line of centrifugal compressors

Single stage design. Sizes from 30 to 600 HP.
Pressures from 1¼ to 3¾ lbs.

If your job calls for delivery of large volumes of air or gases at high pressures, dependable American Blower Single Stage Centrifugal Compressors are just the ticket.

They're compact, require minimum foundations, are adaptable to all types of drives — electric motor, turbine or engine.

Except for the bearings, no other parts come in contact with each other — holding maintenance to an absolute minimum. Air or gases do not become contaminated since no internal lubrication is required.

Prior to shipment, each American Blower compressor is thoroughly tested in accordance with the A.S.M.E. Power Test Code for Centrifugal Compressors and Exhausters.

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He Was the Last Man

Pfc. Hector A. Cafferata Jr.,
USMCR
Medal of Honor

IT WAS DURING the Chosin reservoir fighting. Against F Company's hill position. Reds were attacking in regimental strength. The last of Private Cafferata's fire team-mates had just become a casualty, leaving a gap in the defense line. If the enemy could exploit it, they could smash the entire perimeter.

Exposing himself to devastating fire, Private Cafferata maneuvered along the line. Alone, he killed fifteen Chinese, routed the rest, and held till reinforcements plugged the hole.

The Reds hit again. A grenade fell into a gully full of wounded. Private Cafferata hurled it back, saving the men but suffering severe wounds. Ignoring intense pain, he still fought on until a sniper got him.

"If we really want to protect ourselves from the Commies," says Private Cafferata, now retired because of wounds, "we've got to go all out. And one thing all of us at home can do—*should do*—is invest in our country's Defense Bonds. Sure, Bonds are our personal savings for a rainy day. But they're more—they're muscle behind our G.I.s' bayonets, too!"

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R-S valvEvents

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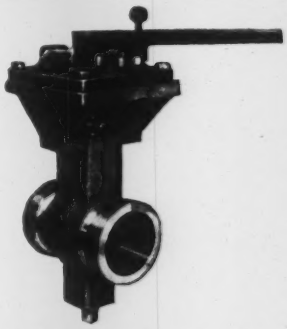
R-S Valves provide quick opening yet tight means of overflow control. Photograph courtesy William Allen Son's Company, Worcester, Mass.

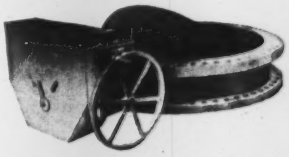
Specify R-S VALVES

- for simplified and economical control and shut-off of volume and pressure
- with metal to metal seat including babbit or rubber seat
- for manual or any type of automatic control
- for any material that flows or is forced through a pipe
- in any material that can be cast or welded including plastics and certain alloys especially adapted to resist corrosion, erosion and temperature.
- in all sizes for all industries and processes, and in the temperature range from minus 300° to plus 2000° F. 2 to 2500 psig.

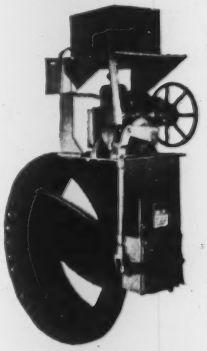
Representatives are listed in telephone directories as: "R-S Products Corporation Valves".



No. 674—Special 2½-inch stainless steel valve with 150 psi construction. Standard sanitary type threads. Heavy duty handlever assembly Type No. 681.



No. 848—Heavy duty valve with rubber seat for water service at high velocity. Handwheel operates valve through spur gear and pinion into a threaded reach rod (enclosed Type No. 700) in order to obtain sufficient torque to seat disc in rubber.



No. 847—Heavy duty valve with electric motor operator mounted directly above valve and positioned by pressure controller mounted above the motor.

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THE American Society of Mechanical Engineers promotes Mechanical Engineering and the allied arts and sciences, encourages original research, fosters engineering education, advances the standards of engineering, promotes the intercourse of engineers among themselves and with allied technologists; separately and in cooperation with other engineering and technical societies, and works to broaden the usefulness of the engineering profession.

As a post graduate school of engineering, the Society brings engineers into contact with each other, with leaders of thought and with new developments; it fosters the interchange of ideas, develops professional fellowships, and encourages a high standard of professional conduct—all with the purpose of advancing civilization and increasing the well-being of mankind.

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The American Society of Mechanical Engineers
29 West 39th Street, New York 18, N. Y.

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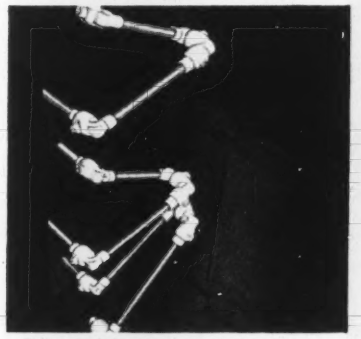
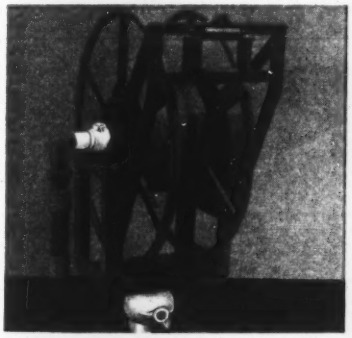
ME-7-53

Chiksan swivel joints in landing gear, braking and hydraulic control systems on Lockheed's Super-Constellation.



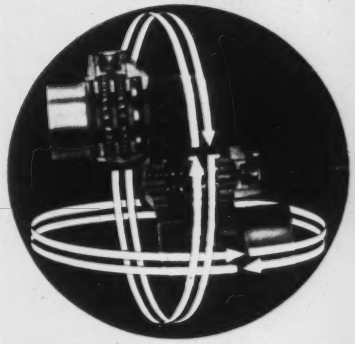
Chiksan high-pressure swivel joints provide complete flexibility and safety in steam lines on platen presses.



Most hose reel manufacturers employ Chiksan swivels for pressure and vacuum tight connections with low torque.

Colorado School of Mines turned to Chiksan swivel joints for air and hydraulic lines on shale mining equipment.

CHIKSAN



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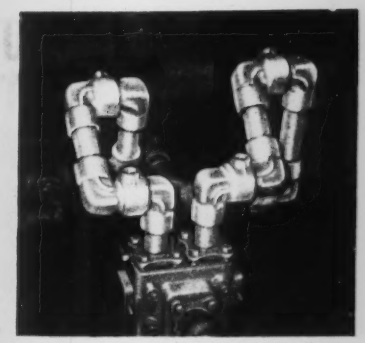
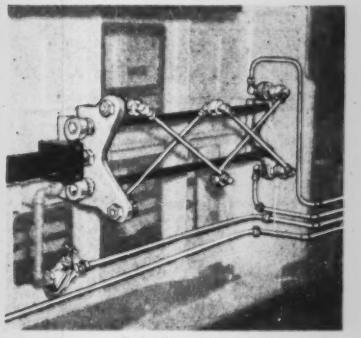
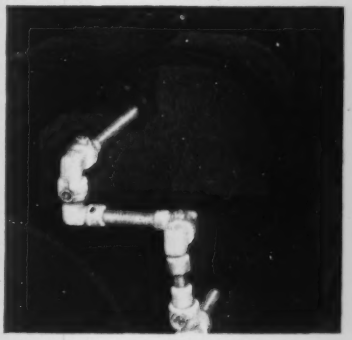


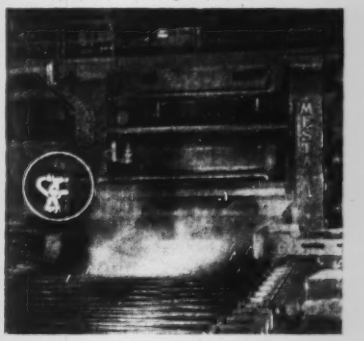
Johnson Motors cut fluid losses 75%—setting-up time 75% with Chiksan joints on their 48 die-casting machines.



Ermold automatic bottle unpacker uses Chiksan hydraulic joints for flexibility and stamina in limited space.



Chiksan high-pressure swivel joints are installed for dependability and safety in injection molding equipment.



Chiksan swivel joints are used on the coolant lines on the 160" plate mill in U. S. Steel's Homestead Works.

CHIKSAN COMPANY • BREA, CALIFORNIA • Chicago 28, Illinois • Newark 2, New Jersey

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Chiksan Export Company (Subsidiary), Brea, California • Newark 2, N. J.

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Variable
SPEED CONTROL

INCREASES PRODUCTION

With "finger-tip" control, machines can be speeded up to increase production . . . adjusted to the speedability of the operator . . . corrected to size or density of parts or stock—temperature or humidity.

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With Lovejoy Variable Speed Control, costly shut-downs are eliminated in the process of changing the speed of the machine to meet varying conditions.

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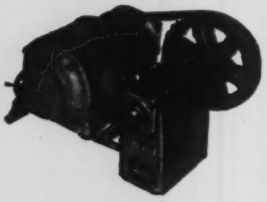
The machines you manufacture, when equipped with Lovejoy Variable Speed Control, have that "extra" sales appeal. Your customers appreciate this added advantage.

LOVEJOY VARIABLE SPEED PULLEY AND ADJUSTABLE MOTOR BASE



Available for fractional to 8 H.P. drives and speed ratios up to 3 to 1.

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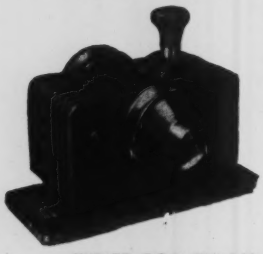

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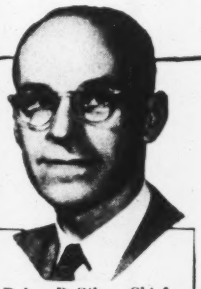

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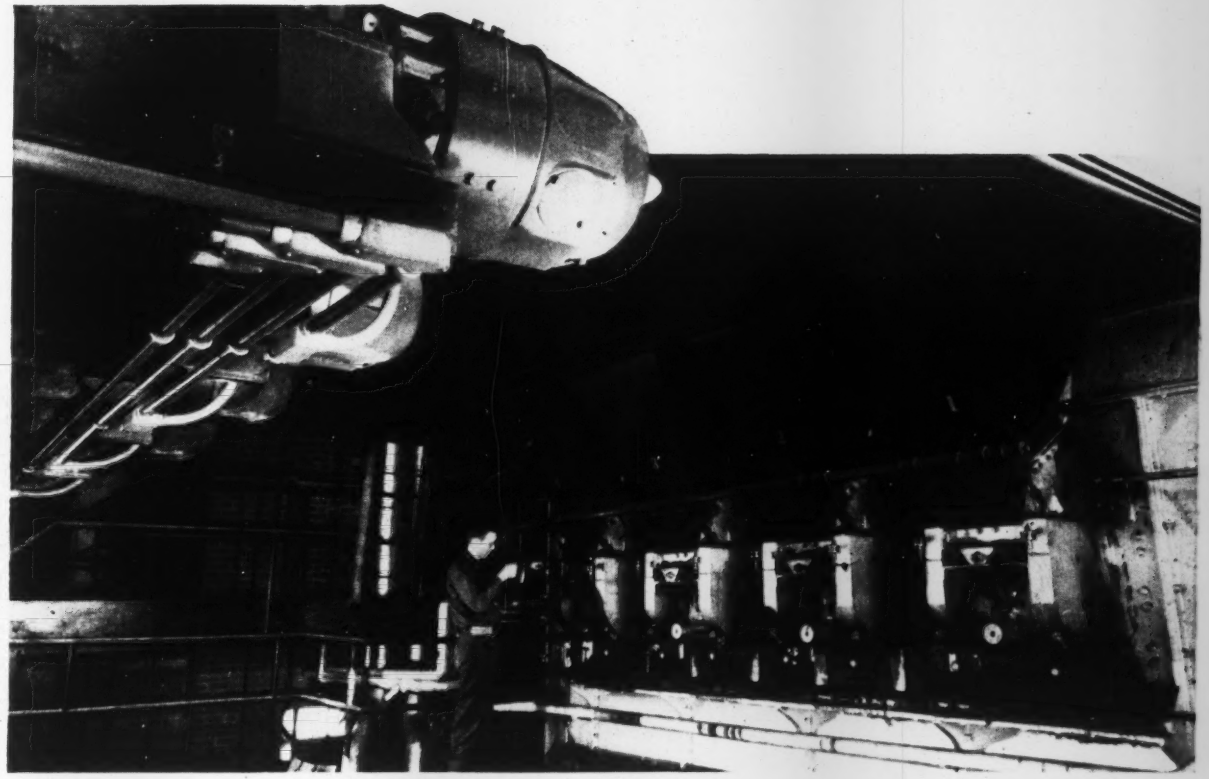

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Putting the best drive in the minimum space is a problem constantly facing design engineers. In answer to this problem, Westinghouse Life-Line Gearmotors provide unit compactness, rugged construction and job-proved efficiency.

Westinghouse Life-Line Gearmotors have both motor and gears designed as an integral unit. As a result, there's a major saving in space because all belts, chains and pulleys can be eliminated. This means no alignment problems. Since integral design lessens the number of wearing parts, over-all maintenance is cut to a minimum.

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Taper-hardened gear teeth, thorough lubrication and industry-tested Life-Line Motors are but a few of the features which assure long, dependable performance from Westinghouse Gearmotors.

Your local Westinghouse Representative will gladly furnish you with additional information. Call him at any time or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. *Trade-Mark J-07322

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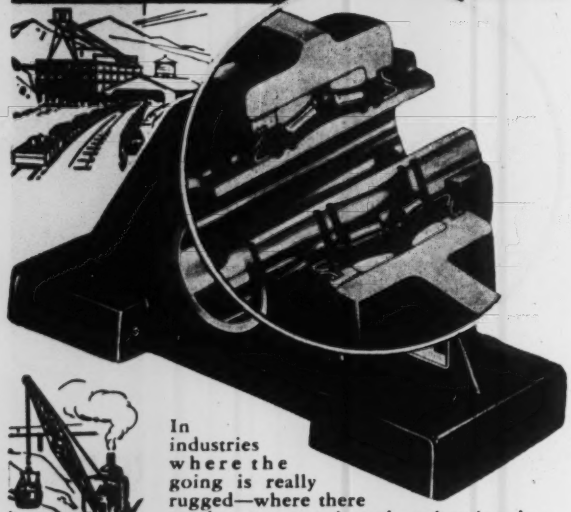

In industries where the going is really rugged—where there can be no uncertainty about bearing dependability, Shafer ConCaVex Bearings get the call. In fact, Shafer Bearings have faithfully served practically every heavy industry for over 3 decades. Add up these advantages and you'll see why:

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Feature for feature—dollar for dollar you get more when you specify Shafers.

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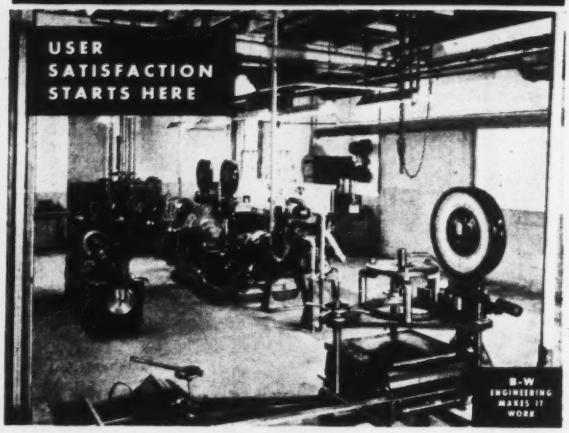
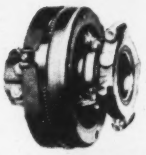


Every type and size ROCKFORD CLUTCH must pass torque, strength, pressure, spin, heat, balance, wear, deflection, friction, run-out, flatness and endurance tests before being put into production. These torture tests are made on specially designed, accurate, clutch-checking machines. Let our engineers give *your* products the benefit of ROCKFORD test-proved CLUTCH reliability.



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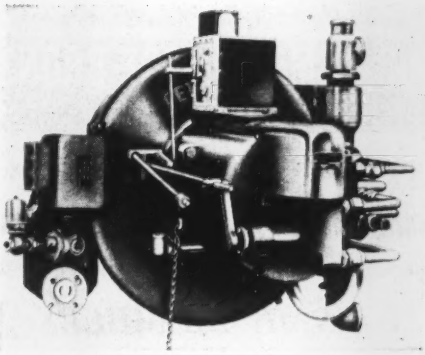
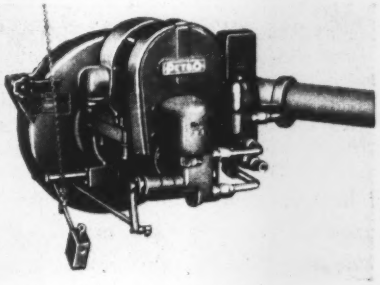
INDUSTRIAL OIL BURNER

to handle it!



Shown above Model WA for use with cold oil.
Also available Model W-AH for use with heated oil.



Model G-W Combination oil-gas.

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Petro rotary oil burners are built for firing all types of boilers up to 600 boiler horsepower, and also for many other industrial applications. They are designed to burn the low-cost, heavy fuel oils with complete reliability, Petro oil burners slash fuel costs two ways—they burn the *lower priced oils*, and they do it with *outstanding efficiency*. Fluctuating steam demands are answered automatically with Petro modulating flame control. Thousands of owners will tell you that Petro Industrial Oil Burners are fuel savers, labor savers and trouble savers, and their dependability is traditional.

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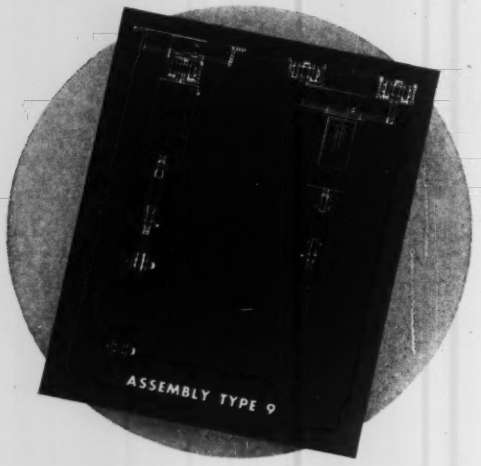
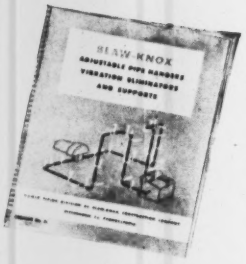


Type 9 Functional Assembly (illustrated) provides free rolling action in two directions and freedom of movement in vertical position. Its *internal swivel* action gives full control over all movements, and minimizes absorption of piping thrusts by the connecting flanges . . . a big help in keeping maintenance and replacement costs at rock bottom. Available for all standard size piping. Accommodates operating loads up to 12,000 lbs.



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POWER PIPING AND SPRINKLER DIVISION
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Sand Cast	125,000	115,000	108,000	100,000	90,000	85,000
Rolled 1" and under	.....	120,000	110,000	105,000	95,000	85,000
Rolled or Forged, over 1"	.....	115,000	108,000	100,000	90,000	85,000
Yield Point (divider method)						
Sand Cast	95,000	75,000	60,000	55,000	45,000	40,000
Rolled 1" and under	.....	75,000	65,000	60,000	50,000	45,000
Rolled or Forged, over 1"	.....	75,000	65,000	60,000	50,000	45,000
Elongation in 2"—%						
Sand Cast	10	12	14	15	20	25
Forged or Rolled	.....	12	13		15	20
Reduction in area—%						
Sand Cast	.....	12	14	15	20	25
Forged or Rolled	.....	12	13		15	20
COMPRESSION						
Yield Point—lbs. per sq. in.	70,000	65,000	58,000	50,000	40,000	35,000
Permanent Set at 100,000 lbs. per sq. in. (max.)	.015	.020	.030	.050	.080	.125
Brinell hardness, No.	250	240	220	200	175	150

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Castings....QQ-B-726 Class B and C

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Castings, Aluminum-manganese Bronze 46B29

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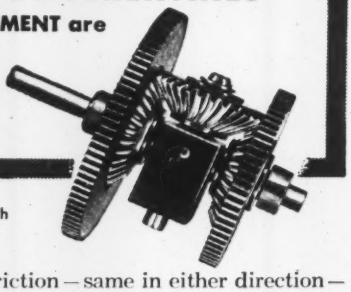

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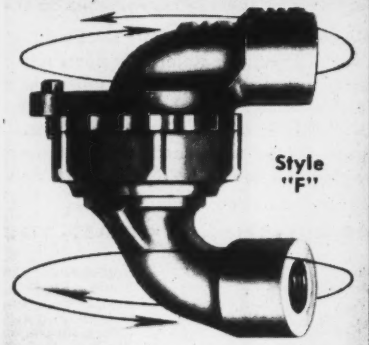

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While preparing this bulletin, we at SK checked with numerous users of SK Gear Pumps to obtain factual operating data.

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SK Gear Pumps *are* well made. And, they are versatile for they can be constructed to handle materials ranging in viscosity from 30 to 10,000,000 S. S. U. Further, depending upon the material handled, capacities can range from 1 gph to 1000 gpm and pressures to 3500 psi.

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In Bulletin 17-A, we have included material which will help to acquaint you with the types and sizes available, their characteristics and uses. If you can use a copy, drop us a line at the address below. We will send it immediately.

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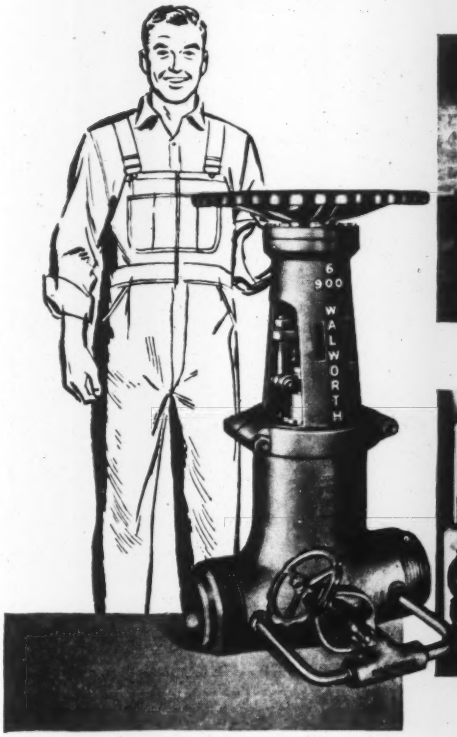
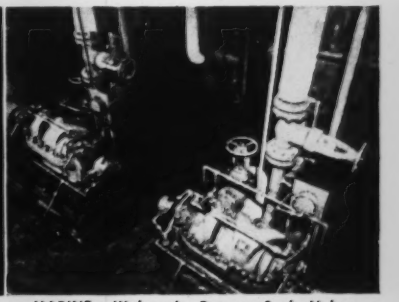
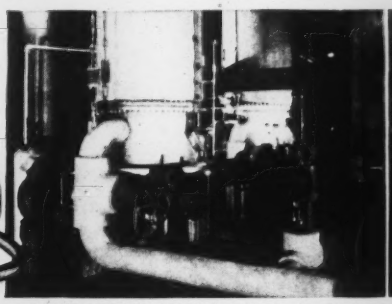


Walworth 6-inch Series 900 Pressure-Seal Gate Valve with Series 1500 Y-type Globe Valve on the by-pass.

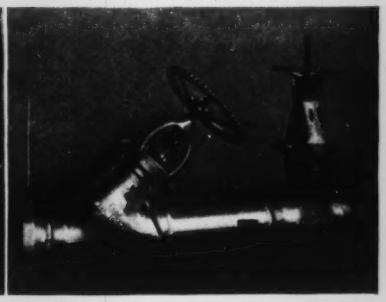
CHEMICAL PLANT: Walworth Pressure-Seal Valves in the pressure reducing station of a chemical plant.



MARINE: Walworth Pressure-Seal Valves aboard the S.S. "Wilfred Sykes"—largest Great Lakes ore carrier.



LIGHT AND POWER: Walworth Pressure-Seal Valves equipped with motor operators, in an eastern public utility plant.



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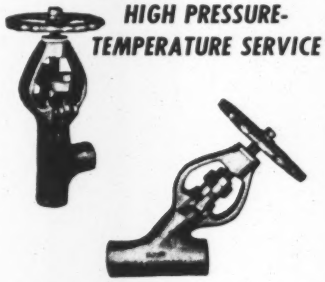

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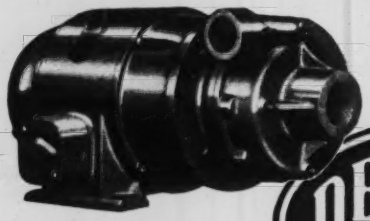

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MECHANICAL ENGINEERING
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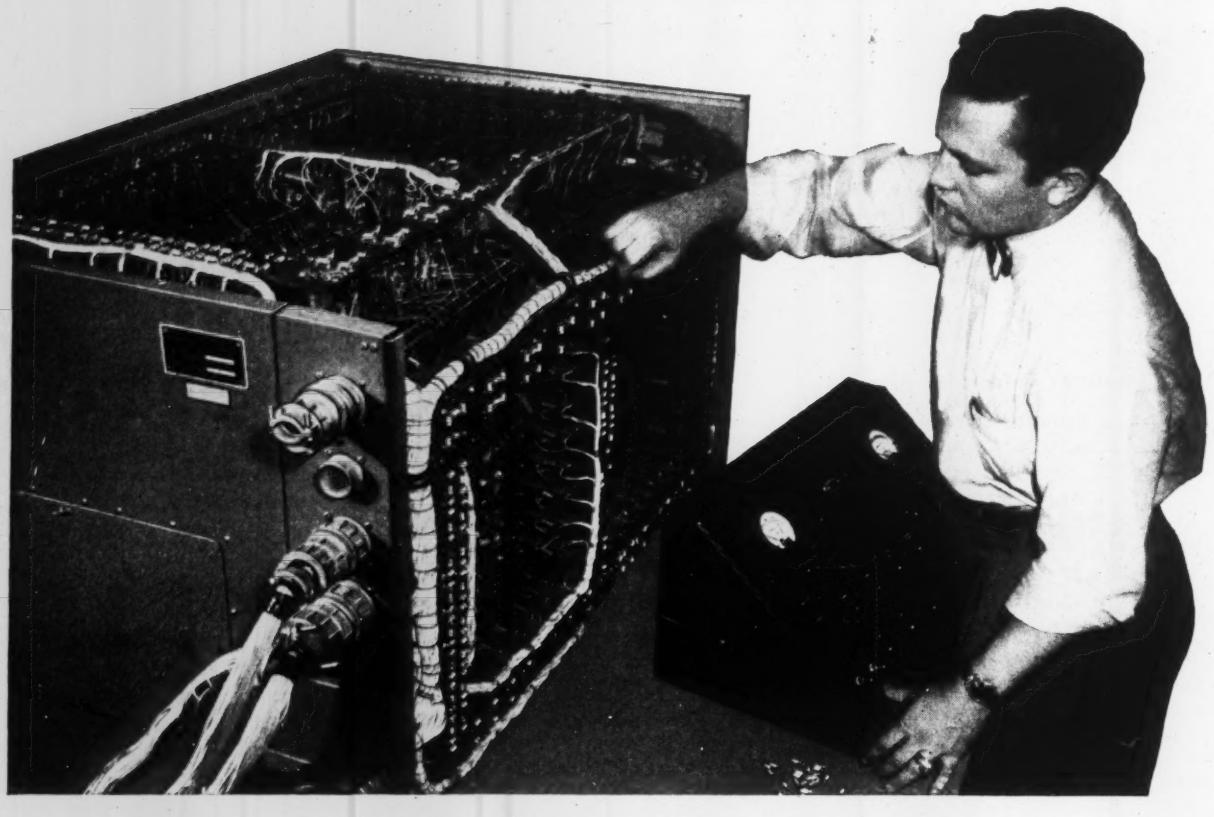

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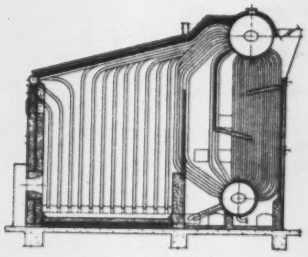

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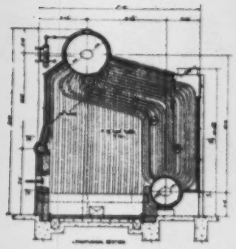

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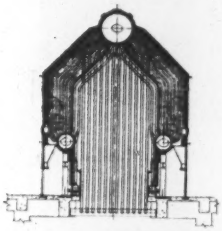

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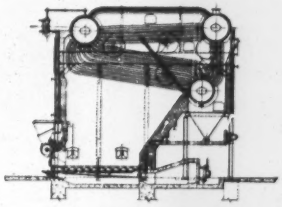

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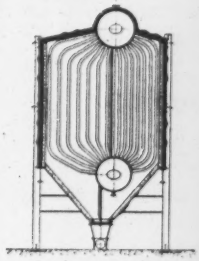

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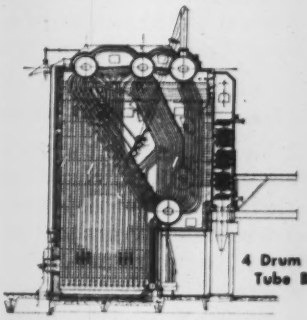

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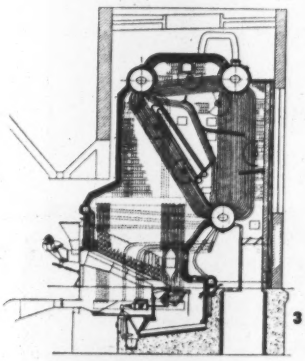

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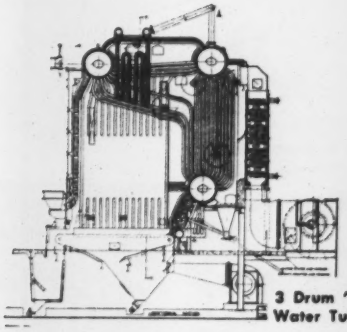

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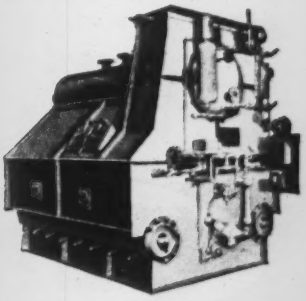

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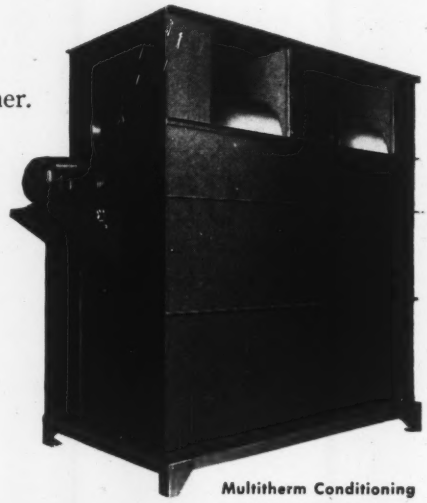

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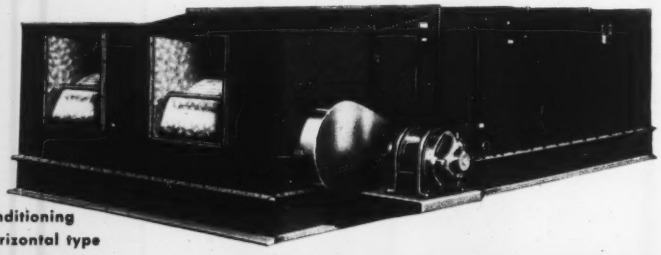

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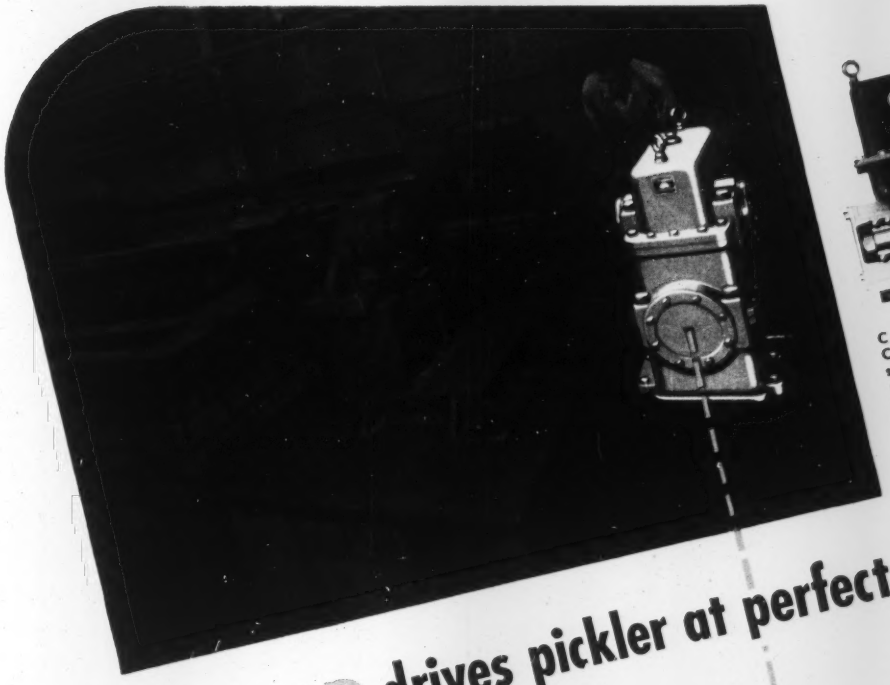
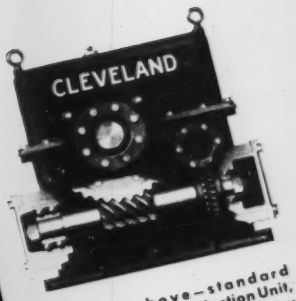




Cutaway above—standard Cleveland Double Reduction Unit, showing high speed and low speed gear assemblies. Cleveland double reduction units available in special designs engineered to serve other slow speed needs. Left — courtesy Precision Drawn Steel Co., Camden, N. J.

CLEVELAND drives pickler at perfect pickling pace

SATISFACTORY pickling of steel requires a drive that immerses and raises bars at a prescribed slow rate. Uniformity of movement keeps the solution circulating evenly and insures efficient descaling.

Steel treated in the mechanical bar pickler shown above is neither underpickled nor overpickled. Installed in a New Jersey plant, it is driven by a dependable Cleveland double worm gear speed reducer. This Cleveland standard unit, incorporating both high speed and low speed gearing, provides a high reduction ratio in very limited space.

Case hardened steel worms running on nickel-bronze gears wear negligibly and run quietly. They contribute to Cleveland's national reputation for long-wearing, inherently quiet drives—drives that transmit power with even, uninterrupted torque flow.

Write today for new Catalog 400 with sizes, dimensions and horsepower ratings of the entire Cleveland line of worm gear drives. The Cleveland Worm & Gear Company, 3264 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

Turns, grooves, faces, bores with automatic accuracy on TIMKEN® bearings

A PLATEN type model, Gisholt's Simplimatic Automatic Lathe can accommodate a wide variety of tool arrangements, every slide with its own drive, rate and direction of feed, but all accurately driven and timed with the spindle. And because all machine functions are automatic, one man can normally operate several machines.

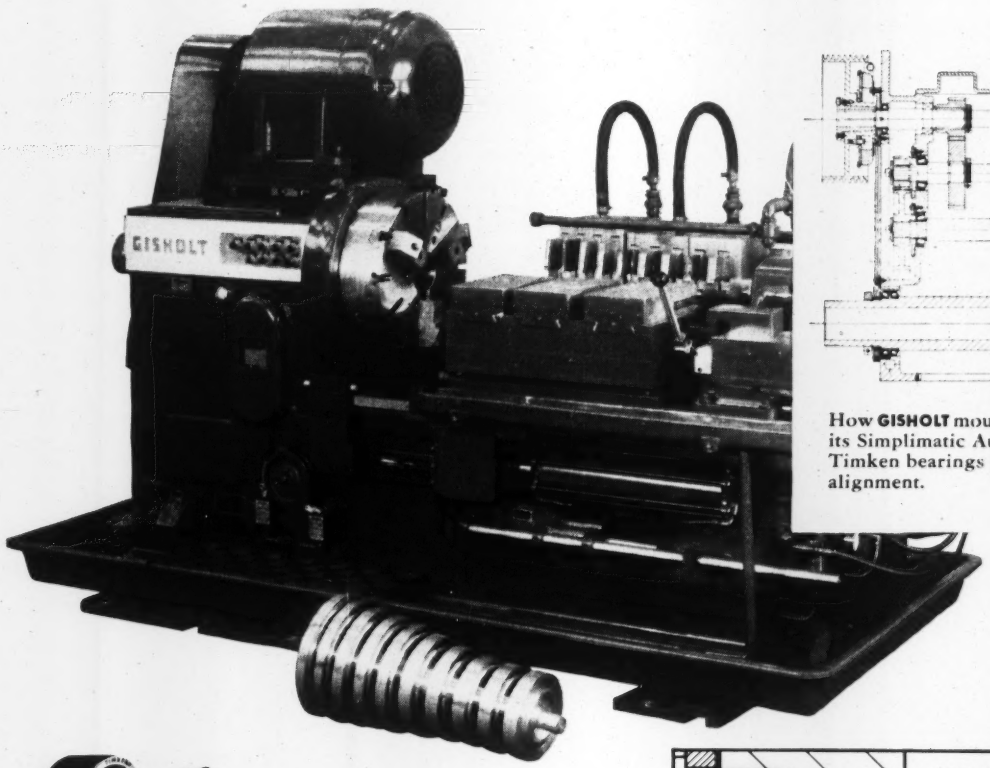
To maintain its incredible precision, Gisholt mounts the spindle and driving gears on Timken® tapered roller bearings. On the spindle, Timken bearings have a greater capacity for tool load because line contact between rollers and races provides load-carrying capacity to spare. Timken bearings in the headstock maintain alignment, help gears mesh accurately with less wear. A smooth flow of power is assured over a wide range of speeds and feeds.

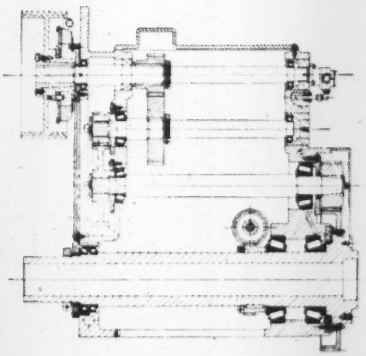
Timken bearings, because of their tapered construction, permit preloading to any desired degree, eliminating chatter. They are made for exacting spindle applications. "Double Zero" Timken bearings are available with maximum run-out tolerances of 75 millionths of an inch.

Timken tapered roller bearings on the spindle take radial and thrust loads in any combination, assuring spindle rigidity. Their true rolling motion and incredibly smooth finish practically eliminate friction. Wear is minimized and precision is maintained throughout the machine's moving parts.

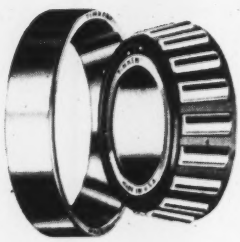
No other bearings can give you all the advantages you get with Timken tapered roller bearings. Make sure you have them in the machines you buy or build. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



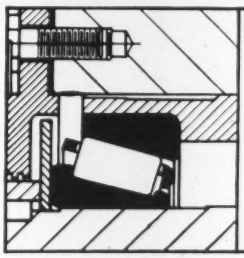


How **GISHOLT** mounts the spindle on its Simplimatic Automatic Lathe on Timken bearings for positive, rigid alignment.



TIMKEN

TAPERED ROLLER BEARINGS



GREATER ACCURACY FOR HIGH SPEED SPINDLES!

Timken bearings in new, semi-flexible mounting insure uniformly high spindle accuracy under varying speeds, loads, temperatures. It permits radial expansion without excessive preloading. Developed by the Timken Company, it's tested and proved. Write for full information.

NOT JUST A BALL ○ NOT JUST A ROLLER ○ THE TIMKEN TAPERED ROLLER ○ BEARING TAKES RADIAL ○ AND THRUST ○ LOADS OR ANY COMBINATION